The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

JULY 15th, 1875.

American Society of Civil Engineers.

The following extract from a circular issued last September, by the above Society, gives, as concisely as possible, the date of its organization, together with its Resources and Objects:

The American Society of Civil Engineers was organized November 5th, 1852; its objects are—the advancement of science and practice in Engineering, the acquisition and dissemination of experimental knowledge, the comparison of professional experience, and the encouragement of social intercourse among its members.

Its membership numbers nearly 450, and consists of five classes: Honorary members, those of great knowledge and experience in some branch of Engineering; members, who, as civil, military, mining or mechanical engineers, have been in active and responsible practice for a term of years: Juniors, who have thus practiced for a briefer term; Associates, who, from scientific acquirements or practical experience, have attained eminence in a special pursuit, qualifying them to co-operate with engineers in the advancement of professional knowledge; and Fellows, who are acceptable subscribers to the funds of the Society. Of these several classes those are termed residents who are within 50 miles of New York, and non-residents who are outside of this circuit. The latter includes members in nearly each of the United States, in Canada, South America, Europe, India, and Japan.

Its resources are: initiation fees and annual dues from Members, Juniors, and Associates, and payments of $250 each to constitute a Fellow, which are exclusively set apart to form a publication fund. By the Treasurer's last report for the Society year ending November 4th, 1873, the assets of the association were:

Cash and stocks.....	$1,786.24	
Dues from members.....	8,505.00	
Fellowship fund.....	8,500.00	
Norman medal.....	1,250.00	$20,041.24
Library and furniture, nominal.....		5,350,00
		$25,391.24

For social intercourse and professional improvement, regular and stated meetings are held on the first and third Wednesdays of each month, except July and August; also an Annual Convention, with excursions to prominent engineering works, either complete or in progress.

Its rooms are at 4 East 23d Street, New York, where the office and library of the Society are; these are open during business hours, and may be used by members as a place of meeting, where appointments may be kept, and letters and packages delivered.

Especial attention has been given to the collection of government, municipal and other reports of public works, and similar records of engineering progress; and endeavors are being made to include in the Library and Museum all that relates to the history, theory, construction, and management of public improvements, and the method and cost of manufacturing operations, with illustrations by models and samples of the results obtained.

Papers and reports presented to the Society, on engineering subjects, with discussions thereon, and other proceedings appear in THE TRANSACTIONS, a monthly publication sent only to members, a few kindred associations here and abroad, and in exchange for leading technological journals, which are kept on file.

The American Society of Civil Engineers, like kindred associations in this country, has led a most precarious existence. Although founded nearly a quarter of a century ago, it is but recently that its present activity was developed, and its praiseworthy career of usefulness begun. It is now entitled to the highest rank among the few scientific associations of this country, and ere long must stand pre-eminent for its practical usefulness and genuine value, as a contributor to the general welfare of the entire community. Some of the most eminent scientific men of the nation are on its list of members, and the importance of the subjects which have been discussed at its meetings will be apparent from an examination of the list which we append further on.

The Society held its Seventh Annual Convention on the 8th, 9th, and 10th of last month, in the city of Pittsburgh. Nearly one hundred members were in attendance at the sessions, and the meeting was one of the most successful and enjoyable that the Society has ever held. In the absence of the President of the Society, the meeting was called to order by the First Vice President W. Milnor Roberts, whose address, slightly condensed, we give to our readers.

Mr. Roberts, in taking the chair, made the following address:

In the absence of the President it becomes my duty as one of the Vice Presidents, to open the Convention, although I believe it has been customary to have some member, not an officer of the Society, to preside over the general meetings other than the business meetings of the Convention.

In recalling to my recollection various events and scenes which have tended to endear the old Smoky City to me, personally, it just occurs to me that a glance at some of them, since they relate as it were, to stepping stones in its progress, may not be wholly out of place or uninteresting, especially to those of our members who now visit Pittsburgh for the first time.

I need not go back with any particularity, to the last century, to old Fort Duquesne, or repeat the story of Braddock's defeat, which unfortunate event occurred about ten miles up the Monongahela river; and I can but glance at the part which the young engineer, George Washington, bore in that memorable battle. More than a hundred years ago, Washington, the Virginia surveyor, pointed to the forks of the Allegheny and Monongahela as the site for a future city, at the head of the noble Ohio, as the point of nearest approach between the waters of the Mississippi and the Atlantic Ocean, and referred to a future water communication. If railroads had been invented at that date, he would undoubtedly have had something to say about a railroad.

Hydraulic engineers—canal engineers, in our country, are, as a rule, older, professionally, than railroad engineers; owing to the circumstance that canals were constructed, and many hydraulic contrivances were introduced into the old world, ages before railroads were invented.

The early internal improvements of our country were naturally patterned after such as had preceded them in the Eastern hemisphere and among the older civilization. One of the first professional civil engineers who figured in the United States was Mr. Weston, who was brought over from England, I think, about the year 1790, to plan and construct the old Union Canal of Pennsylvania, between the Schuylkill and Susquehanna rivers—about eighty miles—extending from Reading, in Berks county, to Middletown, in Dauphin county. He began the work, and constructed some brick bridges, etc.; but it was afterwards suspended for many years. About 1823, Soammi Baldwin, a distinguished New England canal engineer, resumed the work, but in 1824 he gave place to Cawvass White, an eminent engineer from the State of New York, who had been for years actively engaged on the great canal between Buffalo and Albany, "Clinton's ditch," as it was sometimes called, which was begun in 1817 and opened in 1825.

About that time, civil engineering in the United States began to assume definite shape, but only or chiefly in connection with canals and analogous works. There were bridge builders before that in the United States. Among wooden-bridge builders, Burr and Wernwagg had acquired distinction as the constructors of the old bridges over the Delaware at Trenton, the Schuylkill at Philadelphia, and the bridge over the Susquehanna at Harrisburgh. That over the Delaware still stands. A portion of the latter is still in use, although these bridges were built more than sixty years ago. The Schuylkill permanent bridge was destroyed by fire a number of years ago. [It was in 1825, on the Union Canal of Pennsylvania, that the youthful person who now addresses you first drew chainman and rodman's breath as a young engineer. This is mentioned parenthetically—not to be repeated.]

In 1826–27, the first American Railways were laid down, one in Pennsylvania, from Mauch Chunk to the coal mines, nine miles in length; the other in Massachusetts, at the Quincy granite quarries, about four miles long—although it is proper to mention here that *mining railroads* existed prior to that date in the immediate vicinity of Pittsburgh, the planning and construction of which appertained to the working mining engineers of those days.

You all know how railroads starting in that humble way, not quite fifty years ago, have since grown; how they have stretched, spread and ramified through every State and Territory of our expansive and ever expanding Union, until they have come to constitute in the aggregate the most gigantic machinery, as well as the greatest financial investment on the globe.

In the year 1824, William Strickland, architect of Philadelphia, was sent by twenty-four public spirited citizens of that city to England, for the purpose of examining the system then in use (canals), and proposed (railroads), preliminary to entering upon, in the State of Pennsylvania, a grand system of internal improvement. He was accompanied by Samuel H. Kneass, then a young architect and engineer, who made the elaborate drawings for the able report which followed—called "Strickland's Report," and which was published in the fall of 1824, and became the text for the important discussions in the Pennsylvania Legislature, during its session of 1824–25.

Strickland favored the railroad system; but the Legislature after many deliberations, decided to adopt the canal system; and in 1825, immediately after the adjournment, a number of civil engineers, some having previous canal experience, and others not, were put into the field, to survey and locate the main lines of canal between the Susquehanna River and the Ohio, at Pittsburgh.

Messrs. Holgate and Clarke, Pennsylvania surveyors, had previously devised a scheme for a continuous canal, in 1824, having suggested a tunnel four miles long through the great divide of the Allegheny mountain. James Clark, my old and valued friend, who strongly advocated this project, was in consequence thereof ridiculed as a visionary man. Yet there was nothing visionary: he was merely some years in advance of the times. Meanwhile, during the very same year (1825), the grand Erie Canal, 360 miles long, between the Hudson and Lake Erie, was completed and put in operation, confirming the prescience and wisdom of the intelligent few, and astonishing the doubtful many.

Regular railroads were begun in various parts of the country in 1828 and 1829, among them the Baltimore & Ohio, the Albany and Schenectady, the Camden and Amboy, &c. In 1830, dropping for a time my aquatic labors, I became an incipient railroader, and surveyed, laid out, and constructed my first railroad in Schuylkill County, Pennsylvania, and about that time railroad engineers began to be brought forth—obedient to the command—increase and multiply.

It was not till the close of 1833 that the Pennsylvania mixed system, as it became between Philadelphia and Pittsburgh, was completed, although some of the canal divisions were finished somewhat sooner. The railroad from Philadelphia to Columbia, 80 miles, was opened in 1833.

In November, 1833, the first train of cars passed over the Allegheny Portage Railroad, over the Allegheny mountains, 37 miles long, connecting the Juniata and the Western Division State Canals. This was at the time a great road, having ten incline

The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

JULY 15th, 1875.

American Society of Civil Engineers.

The following extract from a circular issued last September, by the above Society, gives, as concisely as possible, the date of its organization, together with its Resources and Objects:

The American Society of Civil Engineers was organized November 5th, 1852; its objects are—the advancement of science and practice in Engineering, the acquisition and dissemination of experimental knowledge, the comparison of professional experience, and the encouragement of social intercourse among its members.

Its membership numbers nearly 450, and consists of five classes: Honorary members, those of great knowledge and experience in some branch of Engineering; members, who, as civil, military, mining or mechanical engineers, have been in active and responsible practice for a term of years: Juniors, who have thus practiced for a briefer term; Associates, who, from scientific acquirements or practical experience, have attained eminence in a special pursuit, qualifying them to co-operate with engineers in the advancement of professional knowledge; and Fellows, who are acceptable subscribers to the funds of the Society. Of these several classes those are termed residents who are within 50 miles of New York, and non-residents who are outside of this circuit. The latter includes members in nearly each of the United States, in Canada, South America, Europe, India, and Japan.

Its resources are: initiation fees and annual dues from Members, Juniors, and Associates, and payments of $250 each to constitute a Fellow, which are exclusively set apart to form a publication fund. By the Treasurer's last report for the Society year ending November 4th, 1873, the assets of the association were:

Cash and stocks.....	$1,786.24	
Dues from members.....	8,505.00	
Fellowship fund.....	8,500.00	
Norman medal.....	1,250.00	$20,041.24
Library and furniture, nominal.....		5,350,00
		$25,391.24

For social intercourse and professional improvement, regular and stated meetings are held on the first and third Wednesdays of each month, except July and August; also an Annual Convention, with excursions to prominent engineering works, either complete or in progress.

Its rooms are at 4 East 23d Street, New York, where the office and library of the Society are; these are open during business hours, and may be used by members as a place of meeting, where appointments may be kept, and letters and packages delivered.

Especial attention has been given to the collection of government, municipal and other reports of public works, and similar records of engineering progress; and endeavors are being made to include in the Library and Museum all that relates to the history, theory, construction, and management of public improvements, and the method and cost of manufacturing operations, with illustrations by models and samples of the results obtained.

Papers and reports presented to the Society, on engineering subjects, with discussions thereon, and other proceedings appear in THE TRANSACTIONS, a monthly publication sent only to members, a few kindred associations here and abroad, and in exchange for leading technological journals, which are kept on file.

The American Society of Civil Engineers, like kindred associations in this country, has led a most precarious existence. Although founded nearly a quarter of a century ago, it is but recently that its present activity was developed, and its praiseworthy career of usefulness begun. It is now entitled to the highest rank among the few scientific associations of this country, and ere long must stand pre-eminent for its practical usefulness and genuine value, as a contributor to the general welfare of the entire community. Some of the most eminent scientific men of the nation are on its list of members, and the importance of the subjects which have been discussed at its meetings will be apparent from an examination of the list which we append further on.

The Society held its Seventh Annual Convention on the 8th, 9th, and 10th of last month, in the city of Pittsburgh. Nearly one hundred members were in attendance at the sessions, and the meeting was one of the most successful and enjoyable that the Society has ever held. In the absence of the President of the Society, the meeting was called to order by the First Vice President W. Milnor Roberts, whose address, slightly condensed, we give to our readers.

Mr. Roberts, in taking the chair, made the following address:

In the absence of the President it becomes my duty as one of the Vice Presidents, to open the Convention, although I believe it has been customary to have some member, not an officer of the Society, to preside over the general meetings other than the business meetings of the Convention.

In recalling to my recollection various events and scenes which have tended to endear the old Smoky City to me, personally, it just occurs to me that a glance at some of them, since they relate as it were, to stepping stones in its progress, may not be wholly out of place or uninteresting, especially to those of our members who now visit Pittsburgh for the first time.

I need not go back with any particularity, to the last century, to old Fort Duquesne, or repeat the story of Braddock's defeat, which unfortunate event occurred about ten miles up the Monongahela river; and I can but glance at the part which the young engineer, George Washington, bore in that memorable battle. More than a hundred years ago, Washington, the Virginia surveyor, pointed to the forks of the Allegheny and Monongahela as the site for a future city, at the head of the noble Ohio, as the point of nearest approach between the waters of the Mississippi and the Atlantic Ocean, and referred to a future water communication. If railroads had been invented at that date, he would undoubtedly have had something to say about a railroad.

Hydraulic engineers—canal engineers, in our country, are, as a rule, older, professionally, than railroad engineers; owing to the circumstance that canals were constructed, and many hydraulic contrivances were introduced into the old world, ages before railroads were invented.

The early internal improvements of our country were naturally patterned after such as had preceded them in the Eastern hemisphere and among the older civilization. One of the first professional civil engineers who figured in the United States was Mr. Weston, who was brought over from England, I think, about the year 1790, to plan and construct the old Union Canal of Pennsylvania, between the Schuylkill and Susquehanna rivers—about eighty miles—extending from Reading, in Berks county, to Middletown, in Dauphin county. He began the work, and constructed some brick bridges, etc.; but it was afterwards suspended for many years. About 1823, Soammi Baldwin, a distinguished New England canal engineer, resumed the work, but in 1824 he gave place to Cawvass White, an eminent engineer from the State of New York, who had been for years actively engaged on the great canal between Buffalo and Albany, "Clinton's ditch," as it was sometimes called, which was begun in 1817 and opened in 1825.

About that time, civil engineering in the United States began to assume definite shape, but only or chiefly in connection with canals and analogous works. There were bridge builders before that in the United States. Among wooden-bridge builders, Burr and Wernwagg had acquired distinction as the constructors of the old bridges over the Delaware at Trenton, the Schuylkill at Philadelphia, and the bridge over the Susquehanna at Harrisburgh. That over the Delaware still stands. A portion of the latter is still in use, although these bridges were built more than sixty years ago. The Schuylkill permanent bridge was destroyed by fire a number of years ago. [It was in 1825, on the Union Canal of Pennsylvania, that the youthful person who now addresses you first drew chainman and rodman's breath as a young engineer. This is mentioned parenthetically—not to be repeated.]

In 1826–27, the first American Railways were laid down, one in Pennsylvania, from Mauch Chunk to the coal mines, nine miles in length; the other in Massachusetts, at the Quincy granite quarries, about four miles long—although it is proper to mention here that *mining railroads* existed prior to that date in the immediate vicinity of Pittsburgh, the planning and construction of which appertained to the working mining engineers of those days.

You all know how railroads starting in that humble way, not quite fifty years ago, have since grown; how they have stretched, spread and ramified through every State and Territory of our expansive and ever expanding Union, until they have come to constitute in the aggregate the most gigantic machinery, as well as the greatest financial investment on the globe.

In the year 1824, William Strickland, architect of Philadelphia, was sent by twenty-four public spirited citizens of that city to England, for the purpose of examining the system then in use (canals), and proposed (railroads), preliminary to entering upon, in the State of Pennsylvania, a grand system of internal improvement. He was accompanied by Samuel H. Kneass, then a young architect and engineer, who made the elaborate drawings for the able report which followed—called "Strickland's Report," and which was published in the fall of 1824, and became the text for the important discussions in the Pennsylvania Legislature, during its session of 1824–25.

Strickland favored the railroad system; but the Legislature after many deliberations, decided to adopt the canal system; and in 1825, immediately after the adjournment, a number of civil engineers, some having previous canal experience, and others not, were put into the field, to survey and locate the main lines of canal between the Susquehanna River and the Ohio, at Pittsburgh.

Messrs. Holgate and Clarke, Pennsylvania surveyors, had previously devised a scheme for a continuous canal, in 1824, having suggested a tunnel four miles long through the great divide of the Allegheny mountain. James Clark, my old and valued friend, who strongly advocated this project, was in consequence thereof ridiculed as a visionary man. Yet there was nothing visionary: he was merely some years in advance of the times. Meanwhile, during the very same year (1825), the grand Erie Canal, 360 miles long, between the Hudson and Lake Erie, was completed and put in operation, confirming the prescience and wisdom of the intelligent few, and astonishing the doubtful many.

Regular railroads were begun in various parts of the country in 1828 and 1829, among them the Baltimore & Ohio, the Albany and Schenectady, the Camden and Amboy, &c. In 1830, dropping for a time my aquatic labors, I became an incipient railroader, and surveyed, laid out, and constructed my first railroad in Schuylkill County, Pennsylvania, and about that time railroad engineers began to be brought forth—obedient to the command—increase and multiply.

It was not till the close of 1833 that the Pennsylvania mixed system, as it became between Philadelphia and Pittsburgh, was completed, although some of the canal divisions were finished somewhat sooner. The railroad from Philadelphia to Columbia, 80 miles, was opened in 1833.

In November, 1833, the first train of cars passed over the Allegheny Portage Railroad, over the Allegheny mountains, 37 miles long, connecting the Juniata and the Western Division State Canals. This was at the time a great road, having ten incline

planes, five on each side of the summit. The gauge was 4 feet 9 inches. The steepest and longest plane had a rise of 10¼ per cent., viz.: nearly six degrees and a length of 3,100 feet. The whole rise overcome on the eastern slope of the mountain was over 1,300 feet, and on the western slope over 1,100 feet. The history of the surveys, location, construction, use, and final abandonment of this old railroad would make a very interesting chapter—postponed for the present.

This combination of canals and railroad, through Pennsylvania, served the public for about twenty years, and until the Pennsylvania Railroad Company constructed their graded road, without incline planes, over the mountains from Altoona, making the present continuous railroad, 356 miles long, from Philadelphia to Pittsburgh.

Pittsburgh had commenced a more rapid growth from the opening of the canal and Portage Railroad system in 1833–34. Indeed, several years before an impetus had been given by the opening of the Western Division of the canal.

In 1832, after the canal had been finished to Johnstown and Pittsburgh, 104 miles, a disastrous and memorable flood occurred, about the beginning of February, which destroyed the canal and locks, etc., in a number of places, and did an immense amount of injury along the Western rivers, public and private. I was at that time engaged as senior principal assistant engineer on the Allegheny Portage Railroad, of which my esteemed friend, Sylvester Welch, was the chief. (His brother, Ashbel Welch, you know well as one of our honored members). I was detailed by Mr. Welch to go forthwith over the entire line of the injured works; to report upon their condition, and to make an estimate of the cost of repairing and rebuilding, rumor having asserted that it would be folly to attempt their resuscitation owing to the enormous cost. This was the occasion of my first professional business to this city. It is only 43 years ago, yet the Pittsburgh of that time and the Pittsburgh which today surrounds us, have but a slight resemblance—only such as there may be between childhood and maturity.

The population of Pittsburgh was then about 16,000—of Allegheny Borough about 3,000. There were only a little over 20,000 people in Pittsburgh and vicinity, where there are now more than 200,000. Allegheny City alone now has about four times the population that was congregated at the head of the Ohio in 1832, while the two cities and adjacent boroughs contained more than ten times the number that were here 43 years ago. Pittsburgh, with about two and a half miles of paved streets, no public lamps, no police, no gas, no city debt, no grand municipal hall; now we see her in the enjoyment of all these modern blessings. Nevertheless, in 1833–34, Pittsburgh built two locomotives for the Allegheny Portage Railroad, which were in profitable use for many years. Mr. Totten, then of the firm of Wade & Totten, a very able Pittsburgh mechanic, took the immediate charge of their construction. I was personally instrumental in obtaining permission from the Chief Engineer to ship a Boston locomotive from Johnstown to Pittsburgh, which served as the pattern for these Pittsburgh locomotives. The fact that locomotives were built in Pittsburgh so many years ago is often forgotten, even by Pittsburgers. The reason is that not another one was built for nearly thirty years, although various efforts were made to establish a locomotive manufactory. For the modern successful introduction of the manufactory, I would refer for information to our friends, Messrs. Porter and Bell.

Major Wade, who was at the head of the extensive foundry and machine shops of those days, and which have for so many years done ordnance work for the United States Government, was a remarkable man, and a very superior mechanical engineer. He was scientific, and he applied his scientific knowledge and great experience, in conjunction with first-class Pittsburgh mechanics, in the most practical and successful manner. Not only Pittsburgh, but the entire country is indebted to Major Wade and his able coadjutors, for many improvements in the construction of the immense guns manufactured at their works, as well as for very useful and valuable experiments and practical success in the mixing and manipulation of the different classes of metal, required to make perfect work for their heavy castings, and heavy machinery of all kinds. The reason Mr. Totten assigned to me for not going on to build more locomotives, was that the work was too trifling, compared with the heavy work they were doing.

Pittsburgh was late in having the advantage of first-class railroads at her doors. It is less than a quarter of a century since the Pennsylvania Railroad was running to Pittsburgh. The Pittsburgh, Fort Wayne & Chicago line was started about the same time, and the Allegheny Valley, the Panhandle, the Connellsville and the Wheeling roads not long after. Now Pittsburgh, as you see, is one of the busiest railroad centers in the country and the passenger and tonnage business here are enormous.

The position of Pittsburgh, as the centre of a great manufacturing district is peculiarly advantageous. At the head of the most extensive system of river navigation in the world; surrounded with hills abounding in bituminous coal of the finest quality, with the adjacent mountains teeming with iron ore; convenient to the great oil regions, and connected therewith by water as well as by rail; within five hours of the lakes, and within twelve hours of the seaboard; in a salubrious climate, and with an abundance of crude essence of kreosote in her atmosphere, it is obviously the "journal" of the universe, where Boston only claims to be the "hub."

It would occupy to much time to give a history of all the numerous engineering works with which Pittsburgh has been associated, some of which, in the march of improvement, and especially in the advancement of the railroad as the predominating element of general transportation, have entirely disappeared from the scene. Of the once famous acqueduct which carried the old State Canal across the Allegheny River, between Allegheny City and Pittsburgh, not a vestige remains. Its demolition has been far more complete than that of the ancient acqueducts of Rome, which still rear their solid time-covered walls conspicuously above the plain. The old canal tunnel, through Grant's Hill, has a history. We once extended the State canal from the Allegheny River to the Monongahela River, and a boat once passed through. This I know, though there may be few others that do. The hill was originally cut down, then an arched canal tunnel was built at the bottom; then it was filled with earth over the tunnel, and street laid out, and houses built over it. In 1839, the canal, the tunnel, and the locks descending to the Monongahela were all nicely repaired at the expense of the State; but the merchants of the city never favored this labor-saving arrangement, and they were all allowed to fall into decay. At a later period, only about ten years ago, the Pennsylvania Railroad Company constructed the present tunnel through the same hill as its outlet, through the Panhandle Railroad, to St. Louis and Cincinnati, crossing the Monongahela on the handsome iron bridge which now spans the stream, whose name is redolent of a famous liquid, which, with the prefix *old*, some love to imbibe. * * *

Iron, among modern engineers, has taken the place of wood, the material with which we old fogies had to work in the olden time. There were it is true, a few iron chain or link bridges, fifty years ago; several of which I saw only a few years later than that date, on the Lehigh River, and there was a wire bridge built by Josiah White, at the falls of Schuylkill, above Philadelphia, more than sixty years ago, over which I recollect being carried. The first modern suspension bridge in this country was, I believe, built over the Schuylkill at Callowhill street, Philadelphia, to take the place of the old permanent bridge, so called, which was a Wernwag wooden, single span of 340 ft. 4 in. This suspension bridge was designed by the late Charles Elliott, assisted by the late John A. Roebling, who was the engineer in the immediate charge and management of the details. Mr. Roebling afterwards rebuilt the old wooden acqueduct at Pittsburgh, and introduced, in an ingenious manner, wire suspension cables for its support; but this structure too disappeared with the abolishment of the canal. At a still later day, Mr. Roebling built the elegant structure called the Allegheny Bridge, which you will see at the foot of St. Clair street, gracefully spanning the stream between the two cities. In sight, above, is the fine, substantial iron lattice railroad bridge, which carries the Fort Wayne Railroad, built by one of our members, Mr. Slataper, and I am very sure that he need not be ashamed of it. At the foot of Smithfield street, over the Monongahela, you will see another suspension bridge, also the work of Mr. Roebling—the oldest iron bridge in this vicinity, which has safely passed a vast amount of very heavy tonnage. There is also the Union Bridge, crossing from the Point to Allegheny, recently finished. It is a handsome wooden structure, well worth seeing. There is to be also a new suspension bride, from the same point on this side to the south side of the Monongahela, to be elevated 80 feet above the water, work upon which has just begun.

Across the Monongahela you will find passenger inclined planes, worked by steam, which connect the high plateau with the city, nearly five hundred feet below, up and down which thousands of passengers are daily pleasantly and safely conveyed.

Bridge building, locomotive and car building, steamboat building, engines, machinery, pipes for water and gas, etc., are built here. Here you will see first class modern furnaces, rolling mills, machine shops, and manufactories of all kinds on the largest scale.

The iron ores of Pennsylvania, Missouri, Lake Superior, Lake Champlain and Canada, are here brought together in great quantities, scientifically manipulated, and transformed into every description of iron and steel, and then manufactured into all possible shapes, and finally shipped to every quarter of the Union. The copper ores, from the region around Lake Superior, were at an early day taken in hand by Pittsburgh enterprise, which has in fact, made this city copper headquarters. It is the same with the petroleum trade of Western Pennsylvania, Ohio and Virginia, which largely centers in this city. Strangers may well be surprised at its exports.

About 1838 the city of Pittsburgh embarked in the permanent improvement of the navigation of the Monongahela River, by a system of locks and dams, several of which were completed and opened for use about 1840. This was about the beginning of the coal business, which has since grown to be one of the principal industries of this vicinity. Over sixty million bushels of coal are now annually passed through these locks, and shipped down the Ohio river to the numerous cities and towns along the Ohio and Mississippi, even as far as New Orleans. The first lock and dam are within sight, on the Monongahela now.

For many years the general government has been engaged in improving the low water navigation of the Ohio, by means of wing dams, dredging, etc., but although the permanent improvement of this important stream has been the subject of engineering discussion for nearly or quite forty years, it was only at the last session of Congress that the first appropriation was made to be applied to the construction of the first lock and dam; the dam to be arranged so as to let down and allow boats, etc., to pass freely during freshets, while the lock may be used during low water, when otherwise boats of any size could not navigate. Should this lock and dam system be successfully introduced on the Ohio River, it will add immensely to the transportation facilities of many States, and save millions of dollars annually to the people of a very large portion of the Union.

Even in thus merely glancing at the engineering objects of interest which appertain to this locality, I find that time is consumed, and I must therefore refrain from further draughts upon my memory in this connection. Absence for some years, and the rapid growth of Pittsburgh, not only physically, but intellectually, conspire in reminding me that there are doubtless numerous interesting matters omitted in this hasty survey, to which the attention of our members will be called. The Allegheny observatory, under the auspices of Prof. Langley, has become an institution of more than national repute, yet I have never have had an opportunity of visiting it. The Keystone bridge-building establishment, located here, has from a comparatively small beginning, attained to colossal dimensions, and so with many other things. Old fogies can hardly keep pace with modern strides.

What I have said may, however, serve to show to our members that at no other point in the United States are there to be seen congregated in a space so compact, a greater variety of works especially adapted

to gratify intelligent curiosity, and to afford practical instruction to inquiring minds.

The local committee of our members, Messrs. Shinn, Michaels. and Metcalf, have, I observe, designated some of the works to be visited, and I have no doubt that all of us will be both pleased and instructed be their examination. I think I might safely say, for myself and in behalf of the Society, that we come here not to instruct, but to be instructed.

Sessions for the consideration of professional subjects were set down for each day from 9½ o'clock A. M. to 1½ P. M., and one for the transaction of such regular business as might be brought up—at 7½ o'clock P. M. on Tuesday. These meetings were held in the Select Council Chamber, Municipal Hall; and at the first session it was determined to devote more time than here named to the meetings on Tuesday and Thursday—that on Wednesday the whole day may be spent in an excursion to the water works, the steel and iron works, and other manufacturing establishments in and about Pittsburgh, including the Blair Iron Sponge Furnace, the Lucy Furnace, Dank's Rotary Puddling Furnace, Edgar Thomson Steel Works, Millar Barr & Parkin's Steel Works, Union Iron Works Beam Mill, Keystone Bridge Works, McKeesport Tube Works, New City Water Works, &c., for visiting which, special trains on the various railways had been placed at the disposal of the local committee.

The Convention Dinner was had on Wednesday, at 7½ o'clock P. M., at the Monongahela House, which was headquarters for members attending the meetings.

The remaining available time was devoted to other semi-professional excursions and to meetings for social intercourse, which were duly announced, at the first session of the Convention.

On Friday, June 11th, there was an excursion, by invitation of the Allegheny Valley R. R. and the "Associated Pipe Lines"—to the oil regions of Butler Co., Pa.; returning to Pittsburgh late that evening.

In accordance with the rules governing Conventions, adopted by the Society, December 2d last, a list of topics to be considered at the regular sessions is here submitted with reference to to the Papers treating these subjects, published in the Transactions since April, 1874.

Upright Arched Bridges, J. B. Eads; Draw Spans and their Turn Tables, C. S. Smith; Principles of Construction of, and Calculations of Strains in revolving Draw Bridges, C. Herschel; Utica Lift Draw Bridge, S. Whipple; Replacing a Stone Pier on a Pile Foundation, J. A. Monroe; Foundations for Brooklyn Anchorage, East River Bridge, F. Collingwood; Notes on the Erection of Illinois and St. Louis Bridge, T. Cooper; Reports on the means of averting Bridge Accidents, J. B. Eads; Report on comparative Examination of the principal Pumping Engines in Use, G. P. Low, Jr.; Compound and Non-compound Engines, Steam Jackets, &c., C. E. Emery; Efficiency of Furnaces burning Wet Fuel, R. H. Thurston; Report on the Form Weight, Manufacture and Life of Rails, A Welch; Weight of Rails and breaking of Iron Rails, O Chanute; Report on Railway Signals, J. D. Steel; Rapid Transit and Terminal Freight facilities, O. Chanute, M. N. Forney, A Welch. C. K. Graham, F. Collingwood; European Railways, as they appear to the American engineer; W. H. White; Mechanical Properties of Materials of Construction, R. H. Thurston; Experiments showing the Character and Position of Neutral Axes as seen by polarized Light, L. Nickerson; Resistance of Beams to Flexure, J. G. Barnard; Levees on the Mississippi River, C. G. Forshey; Delta of the Mississippi, considered in Relation to an open River Mouth, J. G. Barnard; Notes on the Flow of the west branch of the Croton River, J. J. R. Croes; Retaining Walls—an attempt to reconcile Theory with Practice, C. Constables; Failure of the Dam on Mill River, J. B. Francis, T. G. Ellis, W. E. Worthen; Memoir of the Construction of a Masonry Dam, J. J. R. Croes; Fabrication of Beton Blocks by manual labor, S. Hamilton; Improvement of the Water Front of the City of New York, J. D. Van Buren, Jr.; Conflagration in the Coal at Kidder Slope, R. Coryell; The Toredo Navalis, or Ship Worm, G. W. R. Bayley; The Education of Civil Engineers, T. C. Clarke.

Astronomical Notes.—No. V.

PREPARED FOR THE ENGINEERING NEWS BY S. W. BURNHAM, F. R. A. S.

The new dome of the Dearborn Observatory is is completed, and the great equatorial has been put in working order by Mr. George B. Clark, of the firm of Adam Clark & Sons, who came here for that purpose. The near approach of Mars to 3 Sagittarii, on the 29th of the past month, was successfully observed, and a series of micrometrical measurements made of the differences of Declination of the two bodies. It is not probable that any regular work will be carried on for the present, but an effort will be made to secure an endowment, and enable the observatory to contribute something towards the solution of the many problems for which the large telescope is peculiarly fitted.

We learn from the *English Mechanic's* report of last meeting of the Royal Astronomical Society, Mr. Marth exhibited a drawing of the orbits of the satellites of Saturn as they would appear about the middle of August next, and explained the importance of observing the conjunctions as the orbits were now apparently closing up, and consequently the position of the satellites as they passed behind or in front of the body or ring of the planet, could be easily determined without a micrometer. Since the time of the discovery of these satellites, the opportunities which these conjunctions offer had been neglected, except 88 years ago, when some observations were made by Bernard, and one observation by elder Herschel, but they were only approximate estimates of the time when a perpendicular from the satellite fell upon the center of the planet as it passed above or below, What was necessary, was an accurate observation of the contact of the satellite, with the body or ring of the planet. He had given an ephemeris of the positions of the Satellites in the *Astronomische Nachrichten*, in the hope that the opportunity for securing so valuable results would be not neglected by any observatory.

A very valuable and interesting communication from Otto Struve of the Imperial Observatory of Russia, has been published in *Monthly Notices* relating to the double star, Σ1728. This is one of the most interesting of the binaries, and has been more regularly observed than perhaps any other of the close pairs. Its period is shorter than that given of any other binary, being only 26 years. It has been measured every year, when not apparently single, since its discovery in 1827, giving data for ascertaining its periodic time with a small amount of error. The orbit is remarkable for presenting the curious phenomenon of one star passing exactly behind the the other twice during each revolution. This arises from the fact that the plane of the orbit is very nearly in the direction of our own system. The pair is at all times a very close one, the distance of the two stars never exceeding 0″.6, and then diminishing until at the end of about six and a half years no elongation can be detected with the largest telescopes. The last occultation occured in 1870-1, since which it has been gradually opening. It was found independently by the writer in May last with a 6-inch refractor, and the distance estimated at 0″.4. In the Star Catalogues this is known as 42 Comae Berenices.

Borrelly, at the Observatory of Marseilles, discovered a new minor planet on the evening of June 8th. Its place was in R. A. 17h 29m 16s, and Decl. −21° 20′ 15″. This is No. 146 in the list of these small bodies already found. No. 145 was discovered by Prof. Peters, at Clinton, June 4th, and at that time was about 2° south of the place given above. The most of these planets shine with about the light of a twelfth magnitude star.

On June 14th, H. L. d'Arrest, Professor of Astronomy in the University of Copenhagen, died in that city, in his fifty-third year. He studied under the celebrated Encke, and in 1848 was attached to the Observatory of Leipsig, and remained there until 1857, when he was called to Copenhagen, where he was retained until his death. He was the discoverer of four comets and the asteroid Freia; but his great work was the study of the nebulæ by means of the spectroscope, to which reference was made in the March number of the NEWS. The last medal of the Royal Astronomical Society was awarded to him, a few months ago, for his distinguished astronomical researches.

During the late transit, Col. Tennant of one of the English observing parties made a nnmber of measures of the Equatorial and polar diameters of Venus, with a double-image micrometer, and has deduced a compression of about 1-250th. Although there is naturally much uncertainty in this result, it was obtained under very favorable cicumstances, the apparent diameter of Venus being nearly eight times its mean value, and it would seem to support the hypothesis that the of rotation is nearly the same as that of the earth, since the compression according to these measures is also nearly the same.

Engineering Notes.

In New Haven, the sewers are cleaned by means of a sewer cleaning truck, the invention of Messrs. A. B. Hill and W. S. McHarg, Assistant Engineers. The truck carries two buckets and is so constructed that it can be readily adjusted to run in a sewer of any size, from 24 inches in diameter upwards. With this truck, two men can do as much work as ten men with buckets.

The City Engineer of New Haven gives it as his opinion that in the sharp, clean sand and gravel of that locality, they have the materials for manufacturing the best cement pipe that can be made, and he prefers sewer pipe made in New Haven, with proper care, to the best Akron vitrified pipe.

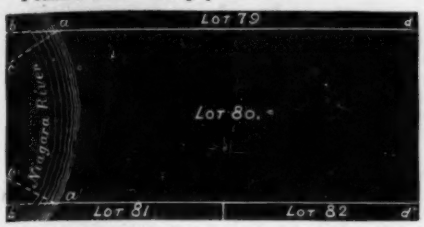
Paterson, N. J., has over 17 miles of sewers. There are 5,785 feet of brick sewers, 7,282 cement pipe, and the balance of 76,740 feet, of vitrified pipe. There are 46,223 feet of 12-inch pipe; 18,194 feet of 18-inch; 8,097 feet of 15-inch. 4,861 feet of 36-inch; 3,675 feet of 48-inch; 3,713 feet of 72 inch; the balance is 10, 24, and 30 inches. From May 1st, 1872, to March 20th, 1875, there was expended for sewers $169,067.14, the average cost per foot of sewer ranging from $1.71 to $4.98, although $6.90 was paid in one case, and even $15.47 and $20.63 in otners.

A. A. Fonda is City Engineer of Paterson, and John T. Hilton, C. E., is Assistant in Charge of Bureau of Surveys.

CORRESPONDENCE.

MR. EDITOR:

I submit the following questions:



Lot 80 was originally deeded by the State of New York as follows: Bounded north by lot 79, east by lot 19, south by lots 81 and 82, and west by the Niagara River." The present owner of lot 80 intends to build a dock and to extend the same about 100 feet west from low water mark—difference between low water and high water about 30 feet. Has he a right to extend his dock on the lines *a b a′b′* (a direct continuation of *a′ d′*), or is he obliged to abide by the lines *a c a′c′* (right angled lines to tan. in *a a′*; and at what point should *a′* be located; at high water mark, low water mark, or at what distance from either?

Do you know of any case similar to this which has been decided in the highest court? do the laws of the State of New York differ, in this respect, from the laws of the Western States? J. F.,

Lockport, N. Y.

ANS.—We can only refer you to the Section on Riparian Rights in Hawes' Manual of Surveying. We are not sufficiently acquainted with the laws of Illinois and New York to be able to state the difference.—ED.

PULASKI, O., June 22, 1875.

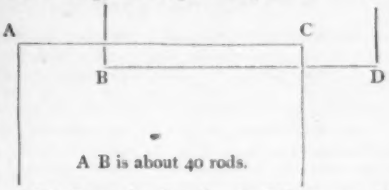
MR. EDITOR.

Dear Sir:—I waited anxiously for replies in the June issue of the NEWS to the questions proposed by "T. H." in the May issue, but was disappointed. By a communication in the August, 1874, number, I had hoped to elicit discussion on a question much similar to his, but failed. When I discover, to my surprise, that there is even a difference of opinion amongst surveyors in the most fundamental part of their work, viz: finding the center of a section—a very essential difference too, I think it high time that surveyors had a more correct understanding about the more complex questions presented by "T. H." Perhaps some are so well convinced as to the proper method of dealing with these questions, that they deem it useless to unite in their discussion; but they will confer a great benefit on the profession if they will present their views on these questions with the law and legal decisions sustaining them. I now present my views on his questions, feeling this, that if my method of practice be incorrect and illegal, I do not fear to be corrected. To the first, I reply that the location of those corners would depend much upon the calling of the deeds; if the land were deeded with the intention of conveying according to the government plat, I would give 20 chains to B_2, and D_3; for K_5 I would measure the east side N. E. ¼ of the section if it corresponded with the distance of the plat, by taking the mean of D C, and East line of N. E. ¼, I would determine what K B should be. If the result was 39.70 ch., as it ought to be for a mean distance, K_5 should have 20ch. If the mean fell short, or exceeded this, I would give K_5 less or more, accordingly.

To the 2nd question, I would divide *pro rata* with the government notes.

As to the third question, my view is given in the August number, when the acres are also mentioned in the deed when, however, no "qualifications" are admitted with the description (which I have not yet found), I would reply that I would give B the ¼ of the ¼, according to the government plat; I wish now to see an ample discussion of these questions.

I would like now to present you a peculiar question which I found not long since in my practice which has also produced some dispute. The old Fulton line as it is called, over which Michigan and Ohio came near having a war in 1835, was the line on which the government surveys of the two States were closed. The surveyors ran down and planted their corners without running on the Fulton line to ascertain whether their corners were in line or not, and by this means I have found some to overlap; I will make a rough draft representing them.



AC is the section line for the Ohio survey, and B D for Michigan, the letters representing the section corners. I ran AC and established the ¼ corner on a direct line, missing B about 8 links. Would you do that, or run from A to B; then from B to C; and C to D, or how? I ask opinions.

As you have opened the mathematical department I send you a problem for which I will give any one credit if he will solve it. E. O.

MR. EDITOR:—I hoped to see in the June number an answer to the questions submitted by T. H. on page 58 (May). As no answer or opinion appeared, however, I will venture an opinion or two which may elicit more valuable ones from others.

It appears to me the question is incomplete and cannot be legally solved from the present data. Give us the length of the section lines between 5 and 6, and between 6 and 7, then we can ascertain the theoretical length of the lines BC and KD. If these agree with the measured lengths, then place 4 and 5 20 chains from K. But why call the corners at 2, 3, 4, and 5 quarter corners Neither of them are ever called so except in the parlance of non-professionals. 2 and 4 are eighth corners, and 3 and 5 sixteenth corners.

Perhaps this is hair-splitting, but professionals must recognize the dignity of quarter section corners more than to allow nine of them to one quarter section. It is like calling every soldier a colonel.

The corners at two and three in the first case supposed, should be placed 10 chains respectively from B and D.

In the second case if there is a surplus or deficit, you must divide it proportionally.

3rd. B can only hold the regular subdivision in accordance with the government survey. Qualification or explanation is only necessary where it is clearly intended to depart from the government survey and establish other lines—explanation is then necessary to express this intention. J. B., Lancaster, Wis.

PENNVILLE, IND., July 7, 1875

EDITOR NEWS.

Will you please answer the following questions in your next issue.

1. To whom and how must application be made to secure a position as Deputy U. S. Surveyor, or a position to subdivide the townships and sections, provided satisfactory evidence of qualifications for either place be presented?

2. Where can the mathematical draughting instruments of Electrum spoken of in February NEWS be obtained, and what the price compared with German silver? Respectfully, A. R.

ANS.—(1) Application must be made to the Surveyor General of the surveying district where a contract is desired. We do not know of any specified form of application.

(2). Electrum drawing instruments may be obtained of W. F. Stanley, London England, or can be imported for you. The cost is 30 per cent. higher than brass, but somewhat less than German silver. The catalogue does not specify.

The "Equal Area System" Exploded.

SHAWANO, WIS., June 30th, 1875.

EDITOR ENGINEERING NEWS.

Dear Sir:—As J. Van B. invites further discussion in order to convince him of the correctness of the "Straight line method," which I am satisfied is adopted by almost every practical surveyor throughout the public land states, with very few exceptions, I wish to make a few remarks in explanation of the rectangular system of U. S. surveys, as required by the U. S. law of February 11th, 1805, as evinced by several years of actual service in the field, in the subdivision of sections, and having for my guidance, complete instructions from the Commissioner of the General Land Office, the Manual of Instructions with supplement, issued by the General Land Office to Surveyors General, and Hawes' excellent manual of U. S. Surveys.

First: The grand object of Congress was to devise a system by which the vast public domain might be cheaply and expeditiously surveyed and subdivided into sections, half sections, and quarter sections, in order that it might be sold at the low price of $1.25 per acre.

Second: The surveys were executed by the Government (in timber as well as in prairie lands, by the aid of the uncertain magnetic compass and crooked chaining through dense timber and thickets,) under contracts with the various U. S. Deputy Surveyors, at a stipulated price per mile; and of course the more miles run per diem, the greater the profit, hence the reasons for the numerous inaccurace surveys which so often puzzle and perplex the county surveyor who is striving under oath and bonds to do justice to the various land owners of every section subdivided.

Third: All of the various corners established by the U. S. Deputy Surveyor are immovable, notwithstanding the Court decision No. 45, Vol. I., ENGINEERING NEWS.

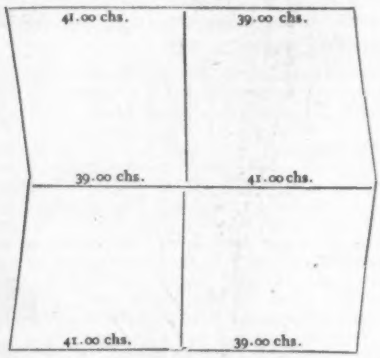
Fourth: All of the various boundary lines of a section, half section, or quarter section, are necessarily *straight* lines, without exception run between known government corners.

Fifth: The absurdity of crooking the quarter lines, contrary to the expressed law, in order to carry out the "equal area system," becomes more and more apparent the further we investigate the matter.

If we admit that the crooking of the quarter lines is just and proper, then we must also admit with the same propriety that the section boundary lines must be crooked at the quarter quarter posts in order to equalize the subdivisions of the various sections. Suppose, for instance that A owns all section 26, and finds by actual survey that the section is smaller than the adjoining sections, in consequence of the various quarter posts having been set inside of a straight line; then A would very consistently claim that the exterior half miles *must* be crooked outward at the quarter quarter posts in order that he might have an equal share with the adjoining sections, or what would be still more reasonable, he might claim, according to court decision No. 45, that the quarter post be moved into straight lines, thus obviating the necessity of crooking lines; but the latter method is entirely impracticable as the law expressly says that the government corners are immovable.

Sixth: Suppose the configuration of a section be as represented by the following diagram, and which shape is found in actual practice frequently, more or less in such a shape *i. e.* the quarter posts are not only out of line. but are *not* equidistant between corners; I have found the half mile lines to vary from one link to thirteen rods, either too long or too short, and I have found the quarter posts out of line nine rods. J. Van B. will discover by careful inspection of the diagram, that his favorite "crooked line theory" would not only make a bad matter worse, but is entirely impracticable; but run *straight* quarter lines as the law *expressly* directs and a just subdivision is the result, so far as the quarter sections are concerned, but continue the subdivision of each quarter section into the forties, and the result becomes very unsatisfactory to the adherents of the "Equal Area Systen" unless the crooked line theory be

adopted in the subdivision of the quarter section.



In the latter application will be seen a complete explosion of the long mooted "crooked quarter line theory," adopted in order to carry out the "equal area system," when the law in every case *expressly* requires *straight* lines between government corners.

Seventh: It being impracticable to cut out the immense amount of timber found, on section lines in order to make them perfect without incurring an enormous expense and often times a great waste of valuable timber. It is reasonable to suppose that Congress was perfectly aware that the various section boundaries must be more or less *crooked*, and the quarter posts *not* equidistant, but, nevertheless, the law says as plain as it can be expressed, by the English language that the half section or quarter section lines must be run straight, and there must be *no* deviation from this well established rule in accordance with expressed laws.

Eighth: Upon a careful investigation of the whole matter I fail to discover any reason why any land owner should reasonably complain simply because upon actual survey he finds that he possesses only 150 acres when his deed calls for 160 acres, while his neighbor in the same section has 170 acres, when his deed calls for only 160 acres, any more than the more extensive land owner of an entire section should complain simply because he finds by actual legal survey that he possesses only 600 acres although he has actually bought and paid for 640 acres according to his deed, while his neighbor in an adjoining section owns 680 acres by actual survey, and only bought 640 acres.

By the "equal area system," the owner of 40 acres can as consistently claim that he must have set off to him exactly one-sixteenth of a section with equal propriety with the owner of 160 acres who claims that he must have an exact one fourth of the area of of the whole section, and either claim is equally absurd.

The section in each and every case as well as the various subdivisions of the same are fully determined by the Government, and there is no remedy whether they overrun or fall short of the required number of acres called for in the respective deeds.

In practice, I have found sections to fall short from one link to 18 rods, and others to overrun from one link to 20 rods, which in either case makes quite a material difference in the number of acres; and further, I have found that sections are never exactly square or have parallel boundaries, one side being shorter than the opposite boundary, hence the *utter impossibility* of making quarter sections or quarter quarter sections of exactly square areas, even if the quarter corners were placed precisely equidistant upon straight lines.

The only remedy which any person has in regard to contents, is to survey the land before purchasing, and if he is not then satisfied with the contents, he is not compelled to purchase, but can look further for lands which contains an excess should he be so avaricious.

Ninth: I would respectfully inform J. Van B. that I was the owner of five forties in the east half of section 18 referred to, which fell short by the legal subdivision, and overrun largely by the *illegal* subdivision by the "crooked quarter line method," and I consider that it is perfectly just and correct that the *straight* quarter lines have been run as the law expressly directs, and I have had the honor of re-subdividing the same and *know* that the quarter lines are *straight*; I will further mention that I have subdivided pine lands in this county (Shawano) worth $7,000. per eighty acres, with straight quarter lines, and the owners are perfectly satisfied with the results, notwithstanding that one half of the section was much larger (55 links) than the other. The law is *very plain* on this point and should not be misunderstood.

The discovery that the repealed "crooked quarter line" law of this State was in direct conflict with the Act of Congress of Feb. 11, 1805, was made by the many intelligent land owners as well as by the numerous practical surveyors throughout the State.

It is presumed that J. Van B. has reference to Court decision No. 45, Vol. I. ENGINEERING NEWS, which he refers to in the defense of the "crooked quarter line theory" and "equal area system."

I consider that said court decision No. 45 is very incorrect, as it does not conform to law, nor correspond with other Court Decisions published in the NEWS, and therefore cannot be relied upon, or adhered to; it demands the removal and correction of the government quarter posts, a matter of impossibility and equally as inconsistent as the "crooked quarter line theory."

The quarter corners, (except on northern boundaries of townships,) and in some few instances the quarter quarter corners have been established by the U. S. Deputy Surveyor in this county, which govern the interior subdivisional lines of the section; but in *no case* have *interior* lines been run by the Government surveyor.

Tenth: In conclusion I would say that all *interior* sections vary more or less in size, although they were sold as containing exactly 640 acres each; and should A purchase the whole of section 36, and subsequent to a careful survey, he finds that he owns a much less number of acres than his neighbor B who owns section 35, and has more land than his deed calls for, it is evident that A has no just cause of complaint, as he can only claim just the amount the Government has surveyed out for him inside of his lawful *straight* half section lines.

The case is exactly the same in regard to any subdivisions of any section; the official plat and the law of Congress governs the subdivisions of every section and the length and positions of the various subdivisional lines are as much determined as though they had been actually run and marked on the ground; although some of the subdivisions may be a trifle larger or smaller than the others,

Surveyors are *not* allowed, by *existing* law, to make any correction of the Government surveys, either by moving the corners or crooking the quarter or other lines.

It will be observed by the careful and unprejudiced investigator that the "equal area system" is practically an impossibility and is in this respect not unlike the theory of "perpetual motion" often studied and harped over, but has never been, nor ever will be accomplished.

Eleventh. In regard to the "due north question," I consider that if any surveyor will take the trouble to thoroughly examine the manual of instructions issued by the General Land Office for the past twenty years, he will have all doubts removed as to the propriety of adopting intermediate courses.

Very respectfully,
J. M., Co. Surveyor.

The strength of copper is diminished one-third in rising from a temperature of 122° to 662°. Iron has been found to increase in strength up to 550°, above which point its strength diminishes.

Wrought iron in being heated from 32° to 350°, expands at the rate of 1 in. in every 450 of its length; and thus a locomotive boiler, 16 feet long, would be expanded nearly seven-sixteenths of an inch, an amount which has been verified by careful measurement.

U. S. Commission on Test of Iron, Steel, etc.

Committee F.—R. H. Thurston, L. A. Beardslee, U. S. N., Q. A. Gillmore, U. S. A.

The board appointed by the President of the United States, under the provisions of An Act of Congress, approved March 3d, 1875, "to test iron, steel and other metals," has instructed this Committee to continue an investigation of those modifications of the various properties of the metals which are produced by changes of temperature.

The Committee are desirous of supplementing these experimental researches with such results of other experimental work and of observation as may be obtainable from authentic sources, they, therefore, solicit such contributions from investigators and observers as may be deemed valuable as assisting in the task assigned them.

The behavior of rails and machinery exposed to the extremes of temperature observed in northern latitudes, where exposed to wear or to breakage, will be likely to afford valuable data. The character of the fracture and the texture of the abraded surfaces, as well as the statistics ordinarily collected, should be noted. Specimens exhibiting peculiarities of behavior or appearance, and photographs of masses which it may not be convenient to forward, will be of value. Where exact quantitative analysis of metals exhibiting unusual characteristics can be given, they will add effectively in the determination of the causes of such peculiarities.

The statistics of well managed railroads are expected to afford useful and reliable information. Rolling mills, producing rails and other forms of rolled iron which are tested by the drop, may be able to furnish more accurate statements of the effect of changes of temperature in modifying resistance to shocks.

Some experimental work has already been done in this field, and it is desired that the results of such researches may be communicated in as great detail and with as much accuracy as possible. Published monographs, reference to papers published in scientific, engineering or other periodicals, and unpublished papers, will be received as valuable contributions.

All assistance rendered the Committee in the endeavor to ascertain the character of the change of the force of cohesion produced in the metals and their alloys by variation of temperature, to determine the mathematical expression of the law, and to obtain such formulas, either exact or approximate, as will make these results conveniently and practically available to engineers and constructors, will be properly acknowledged.

R. H. THURSTON,
Chairman.

DOMINION NEWS.

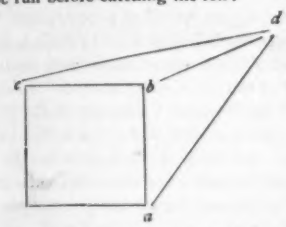
The name of the "Northern Colonization Railway" has been changed to that of "Montreal, Ottawa, and Occidental Railway." This road is expected to be in running order as far as Sault-aux-Recollets Bridge by July 1st, and to Grenville by the close of the present season.

The 5 ft. 6 in. gauge of the Intercolonial Railway was changed last month to the standard 4 ft. 8½ in. gauge. The change was effected over the entire line in one day. The Dominion Government voted $800,000 to carry out the work. The old broad gauge engines, seventy-five in number, would cost $3,000 each to be narrowed down to the new gauge. They will be taken apart and disposed of for what they will bring.

The Extension of Railways in Ontario, in 1874, embraced construction works on new lines of a total length of 662 miles, of which 92 miles were opened for traffic during the year. T. N. Molesworth, C. E., is Engineer of Public Works of Ontario.

Practical Mathematics.

A fox has 60 rods due north the start of a dog; the fox turns a due east course; the dog starting simultaneously bearing his course constantly towards the fox at the rate of 5 rods to the fox's 4 rods; how far will he run before catching the fox? E. O.



Given a point without a square, and the distances from said point to the three nearest corners of the square, the distances being 20, 30, and 40 feet. Required, the size of the square.

Thus $c\,d=40$, $b\,d=20$, $a\,d=30$ } given

to find $a\,b=c\,d$. F. A. C.

On the bank of a river, there is a column 200 feet high, supporting a statue 30 feet high; the statue to an observer, on the opposite bank, subtends an equal angle with a man 6 feet high standing at the base of the column. Required, the breadth of the river.

PUBLICATIONS RECEIVED.

ON THE MOVEMENTS AND REACTIONS OF CONTINUOUS GIRDERS, by Mansfield Merriman, C. E., Instructor of Civil Engineering in the Sheffield Scientific School. Reprinted from the Journal of the Franklin Institute, Philadelphia. 1875.

From E. Gounier, Esq. THE MISSISSIPPI RIVER By W. W. King. New Orleans. 1875.

From Chas. E. Fowler, C. E., New Haven. CITY YEAR BOOK OF NEW HAVEN, 1874-75.

REPORT of the Canal Commissioners for 1874 Springfield, Ills. 1874.

DOCUMENTS OF THE CITY OF NEWPORT for the financial year 1874-75. Newport, R. I. 1874.

ANNUAL REPORTS of the city officers of the City of Paterson, N. J., for the year ending March 20th, 1875.

Notes on Iron.

Wrought iron begins to yield sooner than cast iron under a crushing strain, but after a cube of the former has been compressed to a certain extent, its resistance to crushing becomes considerable greater than that of cast iron.

Bar iron and boiler plate are greatly strengthened by cold rolling under pressure. A bar rolled while cold, from 2⅛ in. down to 2 in. in diameter, was found by Mr. Fairbairn to have been increased in strength by nearly 50 per cent.

The wire ropes employed on railway and canal inclined planes do not wear our by abrasion, but fail, generally, in about two years, by crystallization.

In Mr. Hawkshaw's evidence before the committee on Westminster Bridge, he estimated from the results of Mr. Mallett's experiments, that a cast iron plate of uniform quality and 1 inch thick would remain in clear fresh water for 3362 years before being corroded entirely through, provided but one surface were exposed, or 1681 years if both surfaces were exposed. In the case of foul sea water, it would take 506 years to eat through the plate if but one surface were exposed, or 253 years if both surfaces were subject to the action of the water.

The crushing strength of steel is about four times greater than the tensile strength of wrought iron, and hence a 1-inch punch of steel will just punch a 1-in. hole in wrought iron 1-inch thick.

The majority of such careful experiments as have been made, go to show that hot blasting iron, made from a given quaanty of ore is not inferior in strength to that made from the same ore under a cold blast. The hot blast permits the use of inferior ores, which could not be worked with any satisfactory result under a cold blast.

Cast iron, by being slowly annealed, becomes malleable. The malleable castings used at Mr. Hobb's lock factory may be subjected, without fracture, to nearly all the tests of wrought iron.

Cast iron contracts, in cooling from the melted state, from 1-16 in. to 3-16 in., and it has been occasionally remarked that the shrinkage of cast iron made during the last ten or twelve years is less than that of iron made at an earlier period.

Iron and steel, while heated to a cherry red, can no longer be magnetized, nor are they then susceptible of any magnetic influence whatever.

In Messrs. Robert Napier & Co.'s experiments upon iron and steel, one bar of Jewett's tool steel bore, before breaking, a strain equal to 148,294 lbs. per square inch, the greatest strain born by any of the steels tested. One bar of Lowmoor iron bore 67,876 lbs. per square inch.

Cast iron, where the surfaces left in casting have been cut away by turning or planeing, will pass water through its pores under a pressure of about 7,000 lbs per square inch.

Cast iron guns and other heavy cast cylinders have been burst, with considerable violence, by hydrostatic pressures. In one case, under a bursting pressure of 9,000 lbs. per square inch, a fragment weighing 170 lbs., was projected to a distance of 21 feet

Locomotive tyres are sometimes removed from the wheels, without taking the latter from under the engine, by first removing the rivets and then expanding the tyre by placing heated segments of old tyre around it, or by enclosing it in a sort of plate metal flue, opened at the top and by making a fire at the bottom.

Cast iron lathe beds, and other similar objects which have been warped by fire, as where workshops have been burnt down, may be approximately straightened by being heated, and by being loaded whilst in that state, with weights properly applied.

The Domestic Needle works, Brockton, Mass., are now running full time with 43 hands, and are unable to keep up with orders. They turn out about 12,000 needles per day, and are sending them all over the country. They are now putting in new machinery for finishing. A New York party lately ordered 340,000 needles, but the order was refused on account of inability to fill it. Needles for all kinds of sewing machines are turned out by the firm.

Notes of Ordnance and Projectiles.

American rifles of the "backwoodsman" kind have a bore of about ½ or ¾ in.; the barrel is very long, and of nearly uniform thickness from end to end, this thickness being equal to the diameter of the bore. The barrels are octagonal on their outsides. The great length of the barrels is to insure accuracy, and the complete conversion of the powder into useful work. The great thickness of the barrel is to prevent recoil or other disturbance in firing.

The average price of cast iron ordnance, as formerly furnished by contract to the Government, was £20 per ton.

The action of a mixture of sulphuric and nitric acid on cane sugar forms a glutinous insoluble mass, which, when first washed with water and dried and then highly heated, explodes without residue. It is known as explosive sugar.

Cast iron guns, cast from the same metal, have been found to withstand harder service when kept a few years, or even a few months before testing, than when fired while new.

Three hundred 13-inch shells have been fired consecutively from a single mortar at intervals of only two minutes each.

A keg of gunpowder, exploded on the crown of an arch of masonry, will generally destroy it. The philosophy of this phenomenon, is that a temporary partial vacuum is created, by the explosion, over the arch, the voussoirs of which are immediately forced by the preponderating pressure of the atmosphere beneath.

Taking the initial velocity of an English rifle-ball as 1,300 feet per second, it makes 200 revolutions per second on leaving the piece.

At Finspong, in Sweden, cannons are cast with iron taken direct from the blast furnace.

A charge of powder, laid upon the surface of a rock more than a few feet under water, will generally, upon its explosion, shatter the rock. In this way Mr. Maillifert broke up some very dangerous rocks in one of the entrances of the New York Harbor. The Vanguard Rock, in Plymouth Sound, was afterwards destroyed in the same manner, a ton of gunpowder having been exploded upon its surface more than 40 feet under water.

The Enfield rifle barrel is 39 inches long, and has three grooves with a pitch of 6 ft. 6 in.

Iron which possesses the highest tensile strength will not necessarily make the strongest ordnance. Under the concussions produced by firing, a certain amount of elasticity is as important as strength.

In some trials made by the French artillery, at Metz, a long rectangular, open-topped wooden trough about 12 in. wide, the same in depth, and 20 feet long was made, one end being of india rubber cloth. On being filled with water, and a common musket bullet fired horizontally into the water, through the india rubber end, the impact so communicated to the water split the trough completely in pieces.

In the explosion of a mortar, under the ordinary charge, at Woolwich, in March, 1856, portions of the iron were thrown to a distance of 800 feet.

The greatest range which can be obtained from a gun is that when the piece is inclined at an angle of 45°.

Law and Legislation

An abstract of decisions of the Supreme Court of the United States and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc. Compiled for the ENGINEERING NEWS by John Dunn, Esq., Attorney at law.

270. When two towns are situated on opposite sides of a river, and both are bounded on the river, the line between them is the centre of the river, measuring from bank to bank. Boscawen v. Canterbury, 3 Foster (N. H.), 188.

271. Though, as a general rule, "an admission by a party of a mistaken line for the true one, has no legal effect upon his title," still, a mutual recognition of a given line by adjoining proprietors, accompanied by actual possession of one or both for the period of fifteen years, will be conclusive as to their respective rights. Spaulding v. Warren, 25 Vt., 316.

272. Where an actual, though erroneous, location of a boundary line has been acquiesced in for a period of time sufficient to bar an entry, it will not be disturbed. Smith v. McAllister, 14 Barb. (N. Y.), 434.

273. If, in the description in a deed, the starting point is the corner or side of a highway, and there is a known. actual corner or side existing at the time of the deed, such corner, and not a corner to be ascertained by a survey of the road, is the corner intended by the deed. Smith v. The State, 3 Zabr. (N. J.), 712.

274. Islands in rivers fall under the same rule as to the ownership of the soil and its incidents, as the soil under water does; if not otherwise lawfully appropriated, they belong to the riparian proprietor on one side, or are divided in severalty between the proprietors on both sides, according to the original dividing line, or *filum aqua*, as it would run if the islands were under water. The filum aqua is ascertained by measurement across from ordinary low water mark on one side to the same on the other side, without regard to the channel or depth of water. When the island is appropriated, the boundary is then midway between that and the mainland. McCulbough v. Wall, 4 Rich. (S. C.), 68.

275. A grant or conveyance bounded by a river, not technically navigable, extends to the *medium filum aqua*, unless the terms used in the writing clearly denote the intention to stop short of that line. —*Ibid.*

276. In locating a plat annexed to a grant, course and distance were allowed to prevail under peculiar circumstances, over other and higher rules of location. Evans v. Weeks, 6 Rich. (S. C.), 83.

277. In a division of land between two parties, if either was deceived by the innocent or fraudulent misrepresentation of the other, or there was any mistake in regard to their rights, the division is not binding on either. Bailey v. Jones, 14 Geo., 384.

278. When the boundary lines of a grant are fixed by the grant itself, the question as to what these lines are is purely one of law. Magee v. Hallett, 22 Ala., 699.

279. It is competent to show by parol a boundary line fixed by the parties, and to identify, in the same manner, the land referred to in a written instrument. McCaleb v. Pradat, 25 Miss., 257.

280. Known and fixed boundaries and monuments, called for in a grant or deed, control the courses and distances stated in the same instrument. Mc Gill v. Somers, 15 Mo., 80.

281. If a deed from the Government of the U. S., or an individual, describes land as partly bounded by a river, the river boundary will be adhered to, though it do not correspond with established corners and monuments. Shelton v. Maupin, 16 Mo., 124.

282. If the owner of contiguous lots agree upon a dividing line between the lots, and use and occupy the respective lots up to this line, for a length of time sufficient to show their understanding and intention—though much less than twenty years—neither of them, or those claiming under them, can afterwards set up a different common boundary. The statute of frauds does not interfere in such a case, Blair v. Smith, 16 Mo., 273.

283. It is not necessary to prove boundaries by a plat of survey or field notes, but they may be proved by a witness who is acquainted with the corners and lines run and established by the surveyor, though he never saw the land surveyed. Weaver v. Robinett, 17 Mo., 459.

284. A and B owned a certain tract of land in common, of which A owned one-third and B two-thirds. Parties, duly authorized, set off B's share to him in severalty At the time of the division, part of the land thus owned in common was covered by a pond of water, and the land set off to B was bounded by the water's edge of said pond, at high water mark, and included two-thirds of the common lot, exclusive of the land covered by the water, and B assented to the location of his share, and the line of the water's edge as his boundary, and went into the possession of his share according to the location and line so agreed upon, and acquiesced therein for the space of about twenty-four years. Held, that said agreement thus executed and acquiesced in, was conclusive evidence that B's share was correctly located, and that the boundary mentioned was an accurate division of the line, and that B and his grantees were equally bound ann concluded thereby. Berry v, Garland, 6 Foster (N. H.), 473.

Notes on Building Material.

Fire-bricks are made from an adhesive clay containing but a small amount of oxide of iron and lime—the less of the former the better; as where a large quantity is contained, it is in danger, at the temperature to which it is exposed, of fusing and forming a silicate of iron.

The London clay contains from 10 to 12 per cent. of water, and when exposed to the air swells greatly, besides cracking in all directions when dried.

Hydraulic mortar was first made in London, in 1796, from the septaria in the isle of Thanet. Roman cement contains from 30 to 40 per cent of clay, and hardens in a quarter of an hour. When clayey limestones are calcined, the theory is that the silicate which is formed when mixed with water, takes up water of crystallization like plaster of Paris, and becomes as hard as rock.

Ordinary bricks will absorb about one ninth of their weight of water.

The great columns of St. Isaac Church, St. Petersburg, are formed each from a single block of red granite, and are 50 feet high, and 10 feet in diameter at the base. When these blocks had been wrought in their native beds, holes were made along their attachments and filled with water which was allowed to freeze, and which thus, by its expansion, separated the columns from their native rock.

An instance is on record of 1000 bricks being well and permanently laid in an hour by a single workman This was done for a wager nearly fifty years ago in the front of the old City of London Tavern, now the site of the Wesleyan Centenary Hall.

The Egyptian granite is of excessive hardness. In setting up the bust of Memnon, in the British Museum, it required six weeks' labor to make a hole in the shoulder, and a great many tools were broken in the operation.

Oak timber in the pier at Calais have endured without decay for more than seventy years.

By a careful observation, 22,625 cubic yards of hard sandstones, quarried in large blocks, made 32,390 cubic yards of embankment; the increase of bulk having been 9,770 yards, or 5-12 of the original quantity.

Cast iron is being largely employed in American cities in place of stone and brick as a material for the better class of commercial buildings.

Eighteen feet of ordinary brickwork weighs one ton.

Hand-made bricks lose one-third, and machine-made one-sixth ,of their weight in drying and burning.

23 cubic feet of sand, or 18 of earth, or 17 of clay, make one ton. 18 feet of gravel or earth before digging make 27 cubic feet when dug.

Last fall twenty young men who wished employment, associated themselves together, paid in small capital, hired a workshop and boarding house began manufacturing toys, tables mats and baskets. They laid aside one-fourth of their wages to accumulate as capital, and in six months saved $1,424 from their wages and $350 in board and washing, making a total saving of $1,874 by this system of self-support.

The Canton Wrought Iron Bridge Co. have now under contract over $160,000 worth of wrought iron bridge work. The work done in this establishment last year ran over $400,000. They are now building a bridge in Iowa, also one at Saginaw with 200 feet swing and 160 feet truss. Span to be on wrought iron cylinder piers, no cast iron being used in railroad bridges. This company have bridges in twenty-five different states, the aggregate length of which will measure 28 miles. Their shops are conveniently situated on the line of Pittsburgh, Fort Wayne and Chicago railroad, with every facility for rapidly turning out and shipping bridge work, the capacity being 150 feet per day.

The National Needle Company, Springfield, Mass., employ 90 hands and turn out 20,000 needles a day, making largely for the Remington Sewing Machine Company. They have been organized two years and own about $75,000 worth special machinery, having lately bought out Cook and Porter, of Newtonville.

TABLE OF CONTENTS.

Permanence of Way..... 85
Survey of the City of New Port, R. I..... 86
The Fever Tree..... 88
The Cause of Overflows in Louisiana..... 88
Street Grades..... 89
American Society of Civil Engineers..... 90
Astronomical Notes—No. V.—by S.W. Burnham, F.R.A.S..... 92
Engineering Notes..... 92
Correspondence..... 93
The "Equal Area System" Exploded..... 93
U. S. Commission on Test of Iron, Steel, etc.,.. 94
Dominion News..... 94
Practical Mathematics..... 95
Publications Received..... 95
Notes on Iron..... 95
Notes of Ordnance and Projectiles..... 95
Law and Legislation. Compiled by John Dunn, Esq., Attorney at Law, Ill. Central Railway.. 96
Notes on Building Materials..... 96
The Mechanical Principles of Structures..... 97
Workshop Practice..... 98

The Mechanical Principles of Structures.

STRENGTH OF BOILERS—PIPES AND CYLINDERS.

The tubular or locomotive boiler is subject to strains of a more complicated kind than the ordinary boiler; the connections of the different parts and the continual motion, caused by expansion and contraction, tends to dislocate the parts attached. Such a boiler consists mainly of the fire-box, the cylindrical barrel, and the smoke-box, which are all attached or riveted to each other, and these parts are subject to different strains. The centre barrel or boiler between the fire and smoke boxes we hereafter will discuss as regards strength; but the fire-box is a structure particularly liable to wear and tear from its position, its isolated partitions or plates, and the numerous perforations required in them for the tubes. These conditions render the inner and outer fire-box particularly liable to derangements, and necessitates greater care in the construction. Being composed of flat thin plates of iron or copper, they are less resistant than the boiler plates to deflection or collapse. They cannot be made thick, as the heat is required to pass through them rapidly, and hence means have to be devised to resist the fluid pressure within. This is done by connecting the plates by copper or iron stays, which screw them together and hold them by riveted ends These stays or bolts counteract the pressure between the inner and outer plates, or fire-boxes, which tends to press the inner one inwards, and the outer plates outwards. Again, the crown plate or top of inner fire-box is flat, and requires support; this is done by a series of ⊥ beams, to which the crown plate is secured by intervening stays or rivets, allowing the plate to be free on its upper surface, so that the water may be in contact with the whole surface of thin plate. Again, the position of the smoke box at the other end of the boiler is subject to the same pressure as the inner fire-box, and has to be made of thicker metal, though the chief source of support are the tubes which connect these two boxes, and which, by the aid of ferrules at the ends, tie the plates together like long ties or stays. In the best boilers these tubes are supplemented by stays or tie-rods of solid metal with outer nuts, so as to hold securely each plate.

IRON PIPES AND CYLINDERS.

We now come to another kind of structure subject to internal pressure; not built up in small sections like boilers, but usually of one casting. Gas and water pipes offer us examples, but we may also class with them steam-cylinders and steam pipes and guns. These structures are generally cast of a thickness much in excess of the actual strain or pressure to which they are exposed, as other conditions besides that of internal strain are required to be met, let us take a cast-iron pipe of 20 inches diameter or bore, and cut a ring from it of one inch in length with half an inch thickness of metal. This will give a sectional area of metal to resist the water pressure of one inch square; and if we take the ultimate tenacity of cast-iron at 16,000 lb. per square inch, this amount of pressure would be necessary to burst the pipe. But taking a fourth of this, or 4,000 lb. as the safe working pressure of cast-iron, such a pipe would bear an internal strain of 200 lb. per square inch, or about 13 atmospheres safely. The pressure in the pipe of course depends on the head of water, and seven tons per square inch is usually taken as the average tensil strength of cast iron. In practice, the thickness of a cast-iron pipe is usually made equal to one-fifth of the square root of its internal diameter in inches, or

$$\text{thickness} = \frac{\sqrt{D}}{5}$$

This gives a substance sufficient for all ordinary pressures. On account of defects in casting, and the porosity of the metal, the thickness, as we have said, is generally made in excess of that actually necessary. The rule for the thickness of cast-iron pipes is founded upon the weight of the head of water taken at 62·5 lb. per cubic foot, the tensil strength of the metal per square inch, and the diameter or bore. As we have seen, the resistance a pipe offers for every inch of its length to the internal pressure equals the cohesive strength of its two sides; and the effective pressure on the pipe is as its internal diameter. Thus the formula becomes:—

$$\frac{62{\cdot}5\ \text{HD}}{2\times144\times16000} = \text{thickness to bear}$$

ultimate resistance of the iron. But the shocks and sudden stoppages of water in motion make it necessary to add to this thickness, and in practice pipes should be able to bear ten times the greatest pressure, this being the testing pressure. The following empirical formula, therefore, may be used:—Thickness=·000144 HD; where H= head of water in feet, and D=diameter or bore in inches. Pipes are tested by a hydraulic apparatus to three or four times the working pressure to which they will be subject. Thus a 10in. pipe under a constant pressure of 150 feet head of water, would be tested to $150 \times 3 = 450$ft.; and its thickness should be $·000144 \times 450 \times 10 = ·646$in. In casting pipes it is very important that they be perfectly cylindrical and concentric in bore; sometimes, in horizontally-cast-pipes, the metal varies in thickness, owing to the liability of the core to get out of the centre. Vertically-cast-pipes are generally truest in this respect, and are best for large castings. Too rapid cooling, or impurities, often render pipes apt to burst; and cylinders have been known to fly to pieces, under a sudden change of temperature, as during frosty weather. All these accidental circumstances should be considered in selecting cast-iron pipes or tubes, and a sufficient test applied. Some pipes, as those used in hydraulic crane-works, require strength, and 700lb. per square inch is a usual pressure.

In laying gas and water-pipes, an amount of care is required in well bedding underneath the pipes; though with all precautions, a certain risk exists. The ground is subject to subsidence, and uneven cross strains are brought to bear upon the pipes, causing one side or the other to become strained in tension, which, together with the internal fluid pressure, is often greater than the pipe can bear. We believe the bursting of pipes is oftener due to this unsuspected cause than the effect of frost, particularly

when the pipes have been laid in newly-made ground. The effects of rust, besides shocks, and other accidents to which pipes are exposed, render it imperative that a large margin of thickness or excess of strength should be given them.

Having given the practical rules for pipes, let us, for a moment, consider the effect of internal pressure upon a cylinder or pipe of cast-iron. It was pointed out by Barlow that the strength of a pipe or cylinder to resist internal pressure, is not in proportion to the thickness of metal; and when we consider the matter it is evident the pressure does not affect equally the whole thickness of the ring. The inner lamina, or surface, becomes first extended, and to a greater degree than the next or middle lamina of the metal, while the outer surface is affected in a still less ratio. Each layer, or lamina, undergoes, therefore, a certain amount of stretching, the inner ones the most, and the outer ones the least; in fact, the strain is unequal, and of varying intensity throughout the thickness. Under these conditions the thickness has little to do with the actual strength unless we can insure its taking equally throughout the same degree of tension. This has been attempted in hydraulic cylinders and gun barrels.

The American plan of cooling the mass of metal from the inside or bore, by the aid of a water core, in which a stream of water is allowed to pass to carry off the heat quickly from the centre, so as to reverse the ordinary cooling process by which the heat passes from the exterior and allows it to cool faster than the interior mass, and thus to become expanded over the still warm core. The latter, on cooling, is then more or less separated from the outer ring, and is less dense and able to take its full strain. To this interesting question, and its bearing upon cylinders and guns, we will return hereafter.

Workshop Practice.

GRINDING IN COCKS AND VALVES.

Although this may be considered a simple job, it requires some little attention. I have often seen a number of cocks completely spoiled, and that in places on pipes where it made it an expensive job to work in others. Never touch brass cocks or valves with emery, but get some silver-sand, put it on a shovel or in a ladle and heat it red-hot. When you take out a plug should it be bearing hard in a bright ring on the upper or lower end, get a small smooth file and draw-file it over, of course taking more off at the full part. Dip the plug in water, and dust it over with the sand; then give it a turn or two in the shell. Take it out and wipe it; if still hard and bright touch it up again with the file, and so on until you get a good average bearing all over. You will find grinding a useful operation if you do not use the file, as the grit will leave the bright part and act on the slack. In grinding do not keep the plug hard down, but dance it up and down; this motion distributes the grit, and prevents the cutting of rings. Sometimes also take it out and smear the grit up with your finger. When ground up wipe it and the shell clean, and rub it in with a little oil. If, however, it is an iron cock, and very bad, use No. 2 emery, though finer will do. File the same as with the brass one. If the shell is very bad, lap it out. The mode of doing this, if you have not a lathe at hand to turn a pattern, is to put a piece of wood through the passage of the plug for a pattern. Get a small flower-pot or similar vessel, fill it with sand slightly damped; stick the plug endways down into the sand, now take out the pattern and put a piece of small square rod or wire down the centre, leave it long enough to bend over for a handle, and run in the lead, get an old file and rub this over until it fits the shell, and grind away. Take the lap out at times and feel it with the finger, as the grit is apt to get in little lumps on lead; if so, just draw-file them off. This mode will grind up a shell in a very short time and if properly done will leave an excellent face. Sometimes you may want a cock to work very easy, and yet be sound, especially if it is overhead. If so, have two recesses or grooves turned on the plug, one just under the passage, the other over. Get some of the best shoemaker's twine and wind it tight into the grooves slightly higher than the surface of the plug. Now work it into the shell. If you think you can tuck a little more in with the blade of a knife, do so; if properly done, it will last a long time, be tight, and work both easy and smooth. If you want to make or order a cock, that is to work by machinery, of course you must guard against jamming or sticking fast, as the steam or heat acting upon the plug first at the moment of starting, is very likely to cause a break in the gear. Therefore you want a cone that will not stick fast and yet not be to acute, as then it might leak. The proper taper is 3in. to the foot; this is the commencement of sliding angles in this position.

A good surveyor will practice the judging of distance, and will often test his ordinary paces when walking, so that he can obtain the length of a line pretty accurately without the aid of a tape or chain. It often happens that he has to cross forbidden ground, over which he cannot chain a line, and then this plan will be found most useful. I was once thus stepping the distance across a large field, the property of a irascible farmer, and had proceeded nearly two thirds of the way, when he confronted me with a big stick, saying, "Hi! you. What business have you on my property? You're a spoiling of these turmits." "My good friend, I am doing no harm." "I'm no friend of yours; I am your henemy. Come, get out of this, can't yer?" "Well, then, my good enemy, you see I have already got two-thirds of the way across this field, and it will do the turmits, as you call them, less damage if I go off them in this direction." "Wall, may be, it wull,; but I'll see you safe off afore I goes away." "Thank you. Good afternoon. 196, 197, 198," and so on, until the line was complete. Sometimes, however, an opposing landowner knows what he is about much better than this simple farmer, and puts the surveyor to considerable inconvenience. Imagine the disgusting case of a friend of mine, who, in taking a line of levels, was constantly confronted by a couple of rustics holding up a large piece of rick-cloth, stretched between two poles. Who could object? They were at liberty to stand where they liked, and hold what they liked, and the old farmer stood by and chuckled derisively. At length, with a bow, the surveyor retired. The next morning the farmer and he met again some distance ahead. "Ah! old fellah," said Hodge, "I did yer last night. I know a thing or two." "Yes," quietly remarked my friend; "but you don't know everything. I was back after dark, and completed my line of levels with the aid of a lantern."

It is not an easy thing to take levels with the aid of an artificial light, but it may be done, and it is useful to know that, with a little care, it can be effected.—*Hints to Engineers.*

Frosted glass, useful for screens, &c., is made by laying the sheets horizontally, and covering them with a strong solution of sulphate of zinc. The salt crystalizes on drying.

Consolidation of Earthworks.

BY JULES GAUDARD, CIVIL ENGINEER, LAUSANNE.

Translated from the French by James Dredge, C.E.

*The execution of earthworks for roads, and especially for railways, is frequently hindered by landslips, sometimes of so serious a nature as to defy all the rescources of the engineer.

In laying down the centre line of a road or of a railway, the regularity of the natural surface is not by any means the sole consideration. The attention of the engineer has to be carefully directed to the nature of the ground; he must avoid, as far as possible, deep cutting in clayey soils, and, above all, in side-lying ground. Embankments, again, should not only be constructed of carefully-selected material, but they should be formed upon a natural surface solid enough to carry their weight without settlement.

It is easy to lay down rules for dealing with simple and well-defined cases, but Nature for the most part presents complicated conditions for the engineer to control. Matter is not purely inert; it possesses, so to speak, a certain chemical or physical life, which becomes gradually converted either into change of material, or into motion.

In the simple case of a cutting or tunnel in rock, the sides of the cutting or the roof of the tunnel may be left unprotected, provided the rock is sufficiently solid. But there are materials which, appearing reliable at first, disintegrate under atmospheric influences; and natural steep sloping beds or stratifications, which induce slips, are not unfrequently encountered. In such cases it is necessary to give special inclinations to the faces of the earthworks, or to protect them with masonry. Or, instead of a cohesive soil, suppose a material, dry, homogeneous and easily disintegrated. In this case the question of stability would also be very simple, for this ground has the property of falling only at certain angles, depending upon its nature, according to which it remains more or less stable. If then the requisite space be available to give the proper slope, no difficulty presents itself; or when the base is limited, the weight of the earthwork can be sustained in a vertical plane by a retaining wall.

The theory of the thrust of earth against, and of the stability of, retaining walls is well known. The theory does not aspire to exactness, but it suffices in practice, provided it is not applied incomplex cases.

Let the wall retain the weight A B, fig. 1. Theory shows that the mass tends to slide along the line C X (straight or rather curved), an intermediate angle between the vertical and the natural slope of the material. Supposing the earth to be in a disintegrated condition, A B lies between the natural inclination and the horizontal, and the prism of maximum thrust A C X is but limited, even when the side A B is indefinitely extended. In these conditions the wall can easily retain the earth behind it.

It would equally serve as a retaining wall for water, in which the limiting surface A B is of course horizontal. Mud, too, differs little from water, excepting that its density is greater.

But imagine that these exists in C D a water bearing seam. This permeable bed saturated with and discharging water, would evidently form a sliding surface, especially as it would almost certainly rest on a more or less impermeable clay stratum, the top of which, softened by the water, becomes slippery and greasy. Here the hypothesis of theory is destroyed, and it may be impossible to construct a stable retaining wall, on account of the great pressure behind, which tends to force it forward or overturn it. The earth toward the surface may also be cohesive, to such an extent that the surface A B has a greater angle than is due to its natural slope; the effect of this would be to increase the divergence between the limiting and the sliding lines A B and C D, and therefore the amount of the moving mass. Natural stratifications, or earthwork, if laid in successive layers behind a retaining wall, also possess a certain sliding tendency, which destroys the hypothesis of the homogeneous theory. It is far preferable to form the earthwork in well-punned layers, in such a manner as to form stratifications, as it were, the sliding angle of which is in the opposite direction to the thrust against the wall.

Retaining walls are often unable to resist the thrust of earth resting on natural sliding slopes. To check this action the footings of the wall should be taken down into the solid ground. Thus stratifications of soft ground can be preserved in their natural state, because the slope is reduced as the lower parts are reached. Even a comparatively light cutting in such a soil must be accompanied with danger. In all these cases, if the conditions are known beforehand, precautions can be taken so as to carry out the work without failure, and to retain the ground after it has been completed. To secure this, plenty of timbering is necessary while the work is in progress, and subsequently the earth must be retained by strutted walls, provided with sufficient outlets for the drainage. Such structures are not ordinary retaining walls, because they do not resist the pressure against them by the inertia of their mass; and they may be strutted either at the base or toward the summit, or, if necessary, both above and below.

The walls of the Blisworth cutting (London and Bismingham railway) are strengthened by counterforts underneath the road-bed (Fig. 2). Overhead strutting is applied in the case of high walls, which threaten to turn over rather than to slide out at the base. Many cuttings in England are thus strengthened by cast-iron struts; as, for example, on the inclined plane at Euston (Fig. 3). In the same paper Mr. Hosking has noticed an arrangement of masonry struts, with counterforts spaced 21 feet apart; the wall itself being counter-arched between the counterforts, to check it from yielding under the pressure at the back (Fig. 4). Struts analogous to these are found at the Moseley tunnel (Birmingham and Gloucester railway). Finally, masonry struts, placed 15 feet apart, and of the form shown in Fig. 5, serve to strengthen the retaining walls of the Chorley cutting (Bolton and Preston railway). These are formed with upper inverted arches to give them additional stiffness. When the cuttings are in side-lying ground, the struts should be inclined (Fig. 6).

From works of this nature to tunnels there is only a step, as the latter may be adopted with advantage instead of very deep cuttings. The small tunnel of Bochat, near Lausanne, was subjected to the action of a landslip so severe that it involved an alteration in the profile of the line, a sufficient evidence of the difficulties that would have been met with had a deep cutting been attempted.

For overhead strutting, the use of iron appears to possess considerable advantages as compared with masonry, when the ground to be retained exerts variable thrusts, according to periods of rain or dryness; in this case it is to be feared that the arches, sometimes exerting a thrust against the walls, and sometimes being thrust by them, incur a danger of eventual failure. The iron arched struts should be made very flat; theoretically, they should only be sufficiently curved to counteract the deflection due to their own weight.

Many other examples might be given; but enough has been said to show, that the mode of strutting at intervals constitutes an efficient means of enabling the retaining wall of a cutting to resist considerable thrust. This mode cannot, however, be applied when there is only one side to retain, or when the heights of the two walls are very unequal. Then other methods have to be resorted to. For example, thick, dry stone walls may be employed, strengthened by long internal counterforts, as in Fig. 7. This class of masonry acts as an efficient means of draining the slope behind, and it gradually becomes hardened into a compact mass, forming, together with the counterforts that strengthen it, a body of firm earth and stone able to retain the mobile material above. Examples of this form of construction may be seen on the Strasbourg railway. On the Lyons line, walls have been employed with dry stone backing, provided with openings through the front of the wall, which is laid in mortar, to discharge the water.

Inclined walls, as in Fig. 8, may often

*From the Proceedings of the Institution of Civil Engineers, 1874.

be more economically employed than those with a slight batter, because the whole of their weight falls on the ground which has a tendency to slip. An example of this may be found on the Versailles railway (left side). The slope of the cutting of Brigant (Blesmes-Gray) is supported by inclined arches (Fig. 9) laid in the slope, the spaces between being filled in with dry stone. The bases of the piers rest upon a continous footing, along the side of the roadway, connected with a similar one on the other side by means of inverts A B, at intervals across the track. These inverts are 39 inches wide, 20 inches thick, and about 16 feet 4 inches apart from centre to centre. The slope is drained by pipes leading into a central culvert, C, below the invert.

The cutting of Loxeville (Paris-Strasbourg railway) was first consolidated by a double row of pointed-arches, having 6 feet 6 inch openings, and 18 feet high for each row, the piers of the upper tier resting on the keystones of the lower arches. The ground consists of a thick stratum of very permeable limestone, upon clays which become disintegrated by exposure to the air. As slips occurred upon this work, a careful system of drainage was established by means of ditches and benched collectors.

The principle of strutted sides can also be applied to unstable embankments, which it is necessary to hold in place, as it were, by a cofferdam. An embankment near the Sevres station, on the Western railway of France, was held together in this manner. Oak sheet piling was sunk on each side of the bank, the two inclosing sides being coupled together by tie-rods, so as to prevent any spreading of the earth. Fig. 10 shows this arrangement. The side slopes were not disturbed; but they only play a small part in the whole, because the lack of adhesion between the earth and oak piling would encourage the falling away of the prism A B C.

PHYSICAL CAUSES OF LANDSLIPS.

So far only the question of retaining earth mechanically has been considered. Walls are often too costly, and are, moreover, in many cases, unreliable. The physical considerations, which play an important part in the problem, and which lead the engineer towards other remedies, will now be dealt with. The most dangerous landslips are not those which take place suddenly and without previous indications, but rather those which are slow and progressive. Frequently they do not occur until two or three years after the execution of the works which induced them. This fact would indicate that the vibration of passing trains helps towards the catastrophe.

It is worth noticing that in canals, which are not subjected to the same vibration as railway works, the ground may become consolidated at the end of a few months. The approach of dislocation is indicated at first by simple fissures, then by small quantities of falling earth, which gradually increase in mass until the entire fall takes place. Such accidents are especially frequent in loamy soils combined with permeable or water-bearing seams. The clay, softened by the water, gradually forms mud. It is true that plastic clay, confined and well consolidated so that it cannot move, forms an impermeable mass able to resist great hydraulic pressure; and it is this property that renders the material so valuable in the construction of cofferdams. But natural beds of clay are seldom homogeneous; they are frequently schistous, and combined with other and soluble or oozy materials, traversed by fissures, worm-holes, or the roots of vegetables; and finally, clay is susceptible to deleterious asmospheric influences.

It will be clearly seen, therefore, that loamy or marly soils, more or less impure and subject to the action of water, become finally disorganized, and fall, at first in small fragments which detach themselves from the main body, and afterwards with more rapid movements, which affect the whole mass as soon as the conditions of equilibrium are changed. Mr. Charles Hutton Gregory mentions experiences gained on the London and Croydon railway, and especially in the New Cross cutting. Two classes of clay were met with—compact London blue clay, and a yellow clay so impure, so full of fissures, and so impregnated with saline materials, that it formed really a highly permeable earth, which could be quickly changed into slimy mud. In the North of Spain a heavy cutting, also lying through a yellow clayey soil, had to be abandoned, and the centre line of the railway shifted.

In certain cases chemical agency is active, and an internal molecular action is set up, which disorganises the mass, impregnates it with water and gas, and changes the actual volume of the material. Thus Mr. Gregory mentions the presence of iron pyrites in yellow clay, which being decomposed by the action of the weather, generated sulphuric acid, that in its turn decomposed the carbonate of lime, and formed crystals of selenite. Mr. Clutterbuck remarks that the blue London clay contains protoxide of iron, and that the superficial beds exposed to the action of the air owe their yellow colour to the transformation of the protoxide to a peroxide.

The action of the atmospheric agencies may be thus explained. Clay, which in the lower beds is comparatively soft but compact, and with slight variations in density, varies greatly, on the contrary, when exposed, according to the state of the weather. In times of heat and dryness it contracts and cracks, whilst after a rain which penetrates the fissures, the clay distends. Renewed dryness re-opens the cracks and increases them, and again the water penetrates deeper than before, while pieces become gradually detached from the surface of the slope. The first slip increases the fissures, uncovers portions previously preserved and sustained, and gives an impulse to new derangements, which are gradually extended. The existence of water-bearing beds within the clay augments the danger, not only on account of the water weeping upon the face of the cutting, or, changed in its regular action by a partial falling of the slope, and acting in the fissures in the same manner as rain—but also because they consitute natural slippery fissures, which complete and hasten the detachment of large masses. Thus, when the fissure A B, Fig. 11, descends near enough to the water-bearing seam C E, the fall of the mass A B E C is imminent, although no disorganization other than the fissure A B has occured. When the fall takes place, a new face is exposed, less stable than the orginal slope, the loam soon changes into a state of semi-fluidity and of unstable equilibrium, unable to sustain itself at any angle.

Frost and thaw contribute also to the destruction of the sides of a cutting. The former hardens and compresses the soil, then the thaw, reducing the water in volume, destroys the cohesion of the earthy particles, and predisposes them to melt in the water; an effect which declares itself immediately by the swelling of the clay. This evil is, moreover, greatly increased if the bed, hardened by the frost, contains water-bearing seams; for, when the thaw takes place, an accident is imminent from the sudden discharge of the liberated water. Heavy rain-storms also exert a mechanical action by their volume and velocity; they wear and furrow the surface slopes, where the rapidity of their flow may become considerable.

Clay soils are not the only ones which offer obstacles to the execution of heavy earthworks. Certain water-bearing sands are quite fluent, on account of their permeability; peaty grounds are compressible, and sink under superimposed load; tufa and marl, firm when protected from the action of the air, quickly disintegrate under atmospheric influences. In the Clamart (Paris-Rennes railway) cutting, it has been sufficient to protect the slopes with masonry revetments, or with vegetable earth well rammed.

In mountainous districts, heaps of fallen materials are met with, fed constantly by the slopes and the rough action of the weather. It is necesssary to arrest these moving soils, either by fascines, by plantations, by retaining walls, or by other means. It is especially in schistous formations that the limiting slopes are unstable, being composed of laminated masses. For the most part, these formations, situated in a locality favorable to

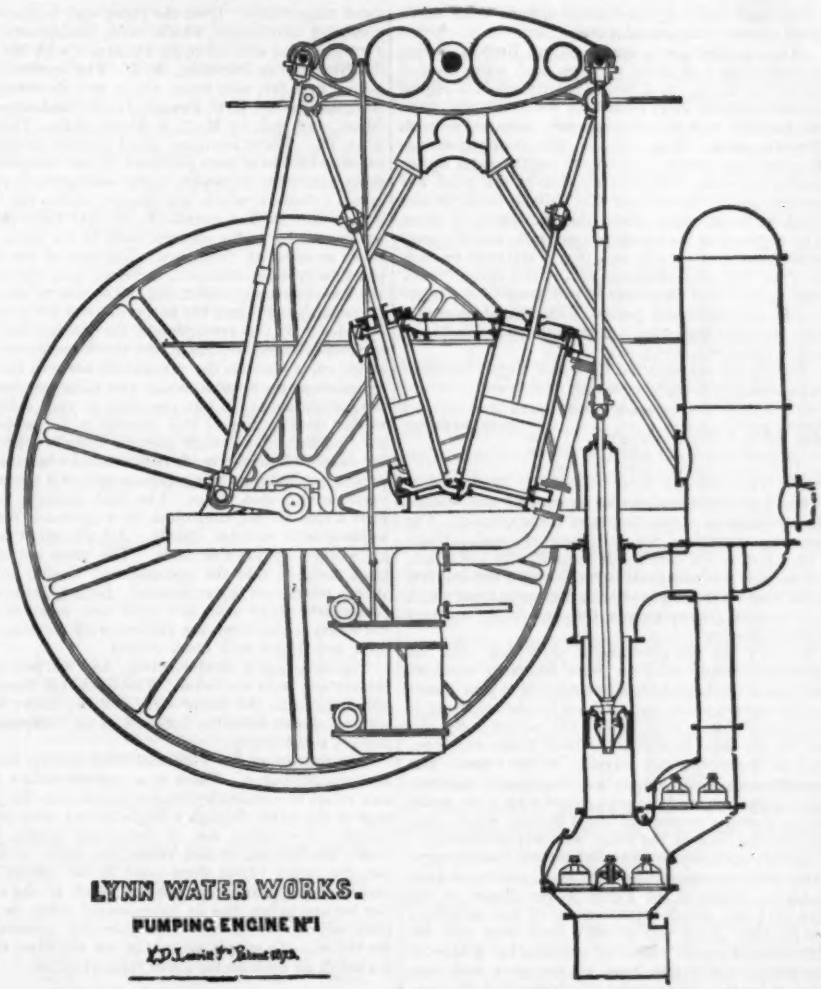
vegetation, are covered with plants which consolidate them in conjunction with surface accumulations. Under these circumstances they can sustain certain weights of embakment, even if they cannot be opened to form deep cuttings. Feldspathic rocks often contain veins or pockets of clay; and, lastly, clayey schists are equally unsafe, especially where they present sliding faces considerably inclined towards the cutting.

Watery seams are dangerous, although sometimes they are so thin as not to be really apparent. The discover themselves, however, on the side of a cutting by the water which passes from them. In cuttings already completed, it is at sunrise that the slight filtrations are most apparent. If necessary, the side may be sprinkled with sand or ashes, which will indicate the position of the humid deposit. If these are visible in bright sunshine and in dry weather, they reveal, as a matter of certainty, the existence of internal water. Roots of trees sometimes produce humid filtrations, and it may occasionally happen that weeping takes place between two beds of clay, and not only at the botton of sandy deposits.

The chief means of dealing with these slippery formations consist—1, in insuring the free discharge of the water by means of channels, drains, or filters, in such a manner that the ground shall be gradually dried and consolidated; 2, to take off the rain or surface water as rapidly as possible, by means of impermeable coverings, benches, or ditches; 3, to preserve the loamy soils from the action of sun, rain, and frost, and sometimes to protect the foot of the slopes with walls, or simple counterforts of well-rammed earth. Success has in general attended the adoption of these measures when they have been applied with judgment. Nevertheless, it will always be prudent in executing work in bad ground to avoid deep cutting or high embankments, to increase the side slopes, and to abstain from carrying out these difficult works in bad weather. The drainage especially requires favourable weather, and it should be conducted simultaneously with the works, to lead off the water from the excavation carried to spoil. The best season is included between the months of March and September.

Concerning the proper slopes to be employed in cuttings in bad ground, it is well to increase them to 2 or 3 of base to 1 of height, instead of employing 1½ to 1, or 1 to 1, which are applicable in good material. This reduction only applies, in some cases, to the slope or strata, inclining towards the railway; the opposite slope can be formed with a greater angle. The theoretical form of the sides should be slightly concave, a form observed after landslips.

[TO BE CONTINUED.]



LYNN WATER WORKS.

PUMPING ENGINE N°1

The Public Water Supply in Cities and Towns.

THE LYNN, MASS., WATER WORKS.

The following article is reprinted entire from the *American Manufacturer*, of Pittsburgh. We are indebted for the use of the wood cut to the courtesy of Daniel Walden, Esq., Superintendent of the Lynn Water Works, from whom also we have received a full report of the Water Board of the City of Lynn. We would have compiled an independent article for our paper if we had had the time, but we feel quite satisfied with the valuable paper of our contemporary, not doubting that it is even more complete than we would have made it.

We propose to furnish from time to time a series of articles on the above topic, confining ourselves to works already in operation or under construction.

This subject is of great public interest because the old methods of water supply fail under the increase of population to furnish pure water. It is at present not the intention to show *why* this is so, but it will be by all thinking persons admitted. We have chosen Lynn, Mass., as the first work to be described, not so much for excellence as a whole, but because the engine in use is, according to the trial by experts, the best pumping engine in the country.

Lynn is situated on the coast, about nine miles north-easterly from Boston. The prominent industry is the manufacture of boots and shoes. In 1865 there were $8,817,711 worth of boots and shoes manufactured, furnishing work to 12,400 men and women, or 50 per cent. of the total population. The population in 1870 was 28,233.

In 1869 the city government, having had its attention drawn to the want of water for the extinguishment of fires, by a destructive fire which has just occurred, petitioned the Legislature for authority to take water, &c. An act was granted to take water from Flax pond, but before being operated it was to be accepted by a two-third vote of those present and voting. This act failed by not securing the necessary number of affirmative votes. This act having failed, the city council decided to make a temporary arrangement with the owner of Flax pond to furnish water to the city. This was done at an expense of $32,000 before the close of the year, and the most important business streets were made secure against a short supply in case of fire. This supply was by gravitation, and gave 25 to 30 feet head.

In 1870 the city government, believing that the rejection of the water act was from lack of sufficient information as to the quantity, quality, and cost of supply, authorized a survey by a competent engineer of the ponds and water sources in the vicinity.

It would seem as if this would be the first thing thought of and done, because unless it is chosen to work in the dark such surveys must be made at some time, and as they will not be likely to cost more if done in the beginning it will give the promoters of the work something to base their calculations upon. It is also a great help in getting an act through the Legislature, especially when towns are near each

other, and their neighbors about to have water taken from sources they consider theirs.

Among other ponds examined was Breed's, having a water surface of about 50 acres, and water shed of about 590 acres. A difficulty having arisen in regard to the supply of water from Flax pond, the city council decided to make a temporary connection with Breed's pond. The cost of this connection was $60,000, and consisted in buying out the water rights, raising the dam so that the altitude of the pond was 62 feet above "mean high tide," giving about 30 feet head on the principal street, and the laying of pipes. The engineer in his report recommends Breed's pond as the source of supply, and that a reservoir be built on Pine Hill, at an elevation of 177 feet above "mean high tide." The water was to be forced to the reservoir by an engine and pumps. The estimate was a little less than $200,000, not including what had been before spent, viz., $133,400.

During the examination for water supply chemical examination was made of water, as follows:

	Organic.	Inorganic.
Breed's pond	1.82	1.95 grains per gallon.
Well No. 1	2.48	5.68 " "
" 2	4.18	19.90 " "
" 3	5.10	24.50 " "
" 4	5.14	18.06 " "

No. 1 as above is about an average of well waters. The deleterious part of the water is the organic. The inorganic consists of mineral substances, and although a person does not care to fill himself with silica, &c., it does not produce great harm. There are but few wells where it is thickly settled, the water from which is fit to drink, the opinion of the users to the contrary notwithstanding.

In 1871 the city government, perceiving that the measures already adopted were favorably received, petitioned the Legislature for authority to issue bonds and introduce water, and an "Act for the supplying of the City of Lynn with water" was passed. By this act the city was authorized to issue bonds to the extent of $300,000, and payable in 20 years. The committee on water supply made contracts amounting to $284,749, and the year closed with 1,420 water takers, giving a revenue of about $9,000, which, considering the state of the work, was very promising.

In July of this year an ordinance was passed regulating the water supply, and the work was to be done under the charge of the Public Water Board of the City of Lynn, which was to consist of five members, one member going out of office each year and his place filled by joint ballot of councils for a term of five years. Until this time all the work had been done under the management of a committee of councils, the members of which were liable to change each year, but under the new organization the majority of the board would be old members and acquainted with the work previously done, which in work of this kind is a great advantage.

Five members for a board are sufficient, and three are better, when the work is desired to be done economically and quickly, if they have an engineer who is *fitted* for the position by reason of *previous* study of and experience in the construction of water works. Most any person learning to do a new thing will make mistakes, and it seems to us not to be economical for a city at its expense to educate men for other places, but that the Chief Engineer should be chosen from those having had experience, and that those desiring to learn should take the position of assistant for a few years. Several examples of this might be given but it is hardly worth while.

Having given a short history of the work to the time when a definite plan was decided upon, we will describe the different parts of the works as they are now constructed. The source is the rain falling upon the water shed of Breed's and Birch ponds of 1080 acres. Breed's pond is the same from which water was temporarily taken in 1870, and before described. The daily supply is about 1,000,000 gallons. The storage is about 150,000,000 gallons. Birch pond, situated a little south of Breed's, and covering 67 acres, was made in Birch brook by building a dam 210 feet long, 16 feet high. This pond has a water shed of 490 acres, and will contain about 200,000,000 gallons. The daily supply is estimated at 1,000,000 gallons. These ponds are connected with the pump well by a 20-inch pipe conduit under 28 and 20 feet head respectively. Over the pump well is placed the pumping machinery, which, with foundations, was furnished and erected under a contract with Mr. Geo. H. Norman, of Newport, R. I: The engine, compound cylinder, with beam crank and fly-wheel, was designed by Mr. E. D. Leavitt, Jr., of Cambridgeport, Mass., and built by Mr. I. P. Morris & Co., Philadelphia, Pa. There are many novel features in the machine, which have been patented by the designer, the most noticeable of which is the arrangement of the steam cylinders, which are located under the beam centre and incline outwardly, so that their pistons are connected to the opposite ends of the beam, and move in opposite directions. The top of the high-pressure cylinder exhausts, therefore, into the top of the low pressure cylinder, and the bottom of the high pressure cylinder into the bottom of the low pressure cylinder. By this arrangement the passage between the two cylinders are made very short and direct. A single valve controls the connection between the two cylinders at the bottom, whilst two valves are used in the connection at the top, one close to each cylinder, so that the capacity of this passage is not added to the clearance of the high pressure cylinder when being filled with steam, nor is it exhausted when the low pressure cylinder is being exhausted. All the steam valves are gridiron slides. The high pressure valves have a cam cut-off, controlled by a governor, readily adjustable to variable speeds. All the other valves are worked by positive cams. The cams are all of large radii, so that the opening and closing of the valves are almost instantaneous, Both cylinders are steam jacketed at sides and ends and together with the steam connections, are clothed with asbestos covering and lagged with black walnut.

The air-pump is double-acting, and worked by a connection with the beam. The discharge from the hot well is into the pump well, and the boiler feed-water is drawn from the hot-well by an independent donkey steam pump.

The pump is of the Thames-Ditton variety, bucket and plunger-pump. There is a supplementary pipe and valves to reduce the friction incident to the passage of the water through a single bucket valve in the piston. The valves are of the usual double beat form; the bottom, or foot valves, are seven in number, the upper valves three—one in the piston and two in the supplementary passage; each of the exterior bottom valves has an independent cover on the chamber, for the readier inspection and removal of the valves. To supply air to the air chamber, there is a small air cock on the lower valve chamber.

TABLE OF DIMENSIONS OF ENGINES.

Diameter of high pressure cylinder	17 1-2 inches
" low " "	36 "
" high " " piston rods	7 "
" low " " piston rods	3 3 4 "
" air pump	11 1-4 "
" pump barrel	26 1 "
" plunger	18 1-2 "
" of fly wheel	26 1-2 feet
Length of stroke of steam and water pistons	7 "
" " air pump	49 1-2 inches.
Distance between end centres of beam	14 feet.
Weight of fly wheel	24,000 lbs
" walking beam	9,500 lbs.
" moving parts connected with beam	11,000 lbs.
Actual capacity of pumps	168.68 gallons per revolution.
Measured " "	194.37 " "
Loss of action in "	0.039564 " "

The boilers are two plain horizontal tubulars, set in brickwork, fired beneath, flame passing the length of the boiler and returning through the tubes to a front connection, thence passing up into a single flue on the top of the boilers in brick work, and to the chimney. There is no clothing at the front end of the boilers. Automatic dampers are attached to the boilers.

DIMENSION OF BOILERS.

Diameter of shell	5 feet
" drum	3 feet
" tubes	3 inches
Length of shell	16 feet
Height of drum	6 feet
Length of grate	5 feet
Width of grate	5 feet 6 inches
Grate surface	27.5 square ft each
Heating surface	1100 square ft. each

The engines and boilers are situated in what is known as the engine house, but divided more properly into the engine house, 50x56 feet; boiler house 40x46 feet, and coal house 41x46 feet. The buildings are of fire brick, with trimmings of Concord granite, having handsome cornices of galvanized iron painted in imitation of granite. The walls of the engine room are plastered and finished below the windows in ash; the ceiling is sheathed and handsomely grained in oak. Connected with the boiler house is the chimney, one hundred and twenty feet high, octagonal in form, and resting upon solid masonry 16 feet in depth.

The water is drawn by the pump from a large well, and discharged through a 20-inch force main, 1904 feet long. This main is of cast iron a short distance, thence by cement-lined sheet iron pipe of the same diameter, to the bottom of the grate house, and thence by a vertical cast iron pipe into the service reservoir on Pine Hill, which, including the embankments, covers an area of about 9 acres. Its interior surface is a little less than five acres, and its depth 18 feet. Its capacity is 20,000,000 gallons. Its altitude is 177 feet above mean high tide. It is distant about two miles from the centre of the city by the line of pipe.

This reservoir was in 1871 put under contract for $70,000, "the contractor to perform all the labor, furnish all the necessary material for its construction, and deliver it in condition for use to the city. In the latter part of 1872 water was admitted, when the reservoir was found to leak. In fact the leak was so bad that the board say: "We regret to report it to be at present almost unserviceable." Nothing was done towards repairs until spring, when it was examined and the contractor released from his obligation upon the payment of $2000, and the city undertook to make it tight. This was done at a cost of $41,602.46.

Upon whom the responsibilfty of this additional cost should fall we do not know, but it was evident some one was at fault. The conclusion *we* should draw is, the necessity of the proper man at the head.

The distributing main starts from the same point the force main enters the reservoir, and is laid in the same trench for about 1,900 feet, where it branches towards the city. The total distribution pipe [wrought iron cement lined] January, 1875, was 48.1 miles. At the same time there was 3800 water takers,

The trial test of the engines gives 103,923,215 feet lb. duty. Your readers will undoubtedly know that "duty" is the number of pounds of water raised one foot high with 100 lbs. of coal.

The duty for the yearly run of	1873	78,990,642 ft. lb.
" "	1874	82,609,785 "

This is the highest yearly duty ever reported. We take the following cost in cents of pumping 1,000,000 gallons 1 foot high by this engine [which will interest those contemplating the construction of similar works] from the report of a "Committee of the American Society of Civil Engineers."

	Attendance.	Fuel.	Repair.	Miscellaneous.	Total, exclusive of interest.
1873	2.100	4.062	0.568	0.678	7.417
1874	2.411	3.865	0.317	0.574	7.167

The total cost of these works, as given in annual report, is as follows:

	January 1, 1873.	January 1, 1874.	January 1, 1875.
Breed's pond, &c	$30,937 16	$30,237 16	$30,305 91
Birch pond, &c		29,966 97	26,100 74
Pipe conduit, &c	7,800 00		43,785 98
Reservoir, &c	60,700 00	126,545 19	131,482 30
Engine house, &c	47,459 00	54,293 83	55,112 79
Engines and boiler	38,156 25	56,618 25	63,019 51
Force main		23,814 00	24,614 00
Distributing mains		437,457 30	450,189 70
Engineering	8,464 99	8,464 99	8,464 99
Service pipe	488,047 30	78,897 64	87,171 85
Meters			3,875 23
Maintenance		98,440 70	44,785 13
Interest			119,618 05
Total		$937,735 94	$1,088,526 18
Water rents to date	$50,189 42	$102,741 48	$162,062 28
Net cash to date	689,534 08	834,994 46	926,463 90
Rents for the year	50,189 48	52,552 06	59,320 80
Per cent. of gross cost		5.6	5.4

A system of Pullman car "en suite trains" is being organized in Philadelphia which will largely relieve the hotels of that city of the burden of providing for the most wealthy and luxurious class of travel during the progress of the Centennial Exposition.

Discharge of Sewers.

The science of Hydraulics, like many kindred sciences, has gradually advanced in improvement until it has reached a high degree of perfection. It had its origin in the days of antiquity, although it is not clear that the ancient Romans, and others, had any formulæ, similar to those now generally used by engineers, to guide them in the construction of their hydraulic works, but it is quite clear that the Romans were practically masters of the laws which govern the flow and discharge of water, as the regulations existing in ancient Rome for the distribution of water through the city bear conclusive testimony that they possessed a clear knowledge of these laws, and also were acquainted with expedients which might be used for fraudulently obtaining a supply of water greater than was contemplated by their regulations. No record has been handed down to posterity of any formulæ that may have been employed in designing those stupendous works of bringing a supply of water into those ancient cities, or for calculating the discharge of the sewers flowing from those cities, and if any such were used they have been lost. After the revival of scientific research, it was not until the fourteenth century that hydraulics came to be considered a branch of science. In the seventeenth century this science received a considerable amount of attention, and from that period it has progressed rapidly towards perfection. Castelli and Torricelli, pupils of Galileo, both contributed largely to the development of this science. The former published a work on rivers in 1628, the latter discovered that by abstracting all resistances the velocity of an escaping fluid from an orifice was equal to that which a heavy body would acquire when falling in vacuo, and he argued that the acceleration in the velocity of streams was due to the slope of the surface of the water. From that period to the middle of the eighteenth century, the science of hydraulics was treated almost entirely as a theoretical deduction, but then commenced the era of experimental investigation. Professor Michelotti of Turin, and Abbe Bossut of Paris, ably represented this new era, but it was left to M. Chezy, in 1775, to reduce the laws of water in motion to simple algebraic formula. This formula, introduced nearly a century ago, is presented in a form to which all subsequent formulæ may be reduced. The formula is here given:—

M. CHEZY'S FORMULA.

$$V=\sqrt{\frac{ghaa}{Alp}}=B\sqrt{rs}.$$

V—velocity in feet per second.
g—32·194.
h—difference in level in whole distance l.
l—length of limited portion of channel.
a—area of cross section.
p—length of wetted perimeter.
A—coefficient or measure of resistance.
B—determined by experiment.
$r=\frac{a}{p}$—hydraulic mean depth.
$s=\frac{h}{l}$—sine of slope.

This formula has been adopted by a large number of authorities, the value of B differing somewhat. As for example:—

Beardmore, 94·2
D'Aubisson, 95·6 for velocities over 2 feet.
Downing and Taylor, 100 for large and rapid rivers.
Eytelwein, 93·4
Leslie, 68 for small rivers; 100 for large.
Neville, 92·3 for velocities under 1·5 foot per second, and 93·3 for greater velocities.
Stevenson, 69 for small streams; 96 for large streams.

The formula most generally used at the present day is that ascribed to Eytelwein introduced in the early part of the present century. It is as follows:—

$$V=\cdot9091\sqrt{2\,H\,r}.$$

which by reduction can be put

$$V=93\cdot4\sqrt{rs}.$$

$$V^1=55\sqrt{2\,H\,r}.$$

H—fall in feet per mile.
V—velocity per second.
V^1—velocity per minute.
r—mean radius or hydraulic mean depth.
S—sine of slope.

Eytelwein found that the velocity per second nearly equals a mean proportional between the hydraulic mean depth and twice the fall in feet per mile. The formula used in preparing the several calculations in the Tables in this book is that of Weisbach, which is here given:—

$$h=\left(1+e+c\times\frac{l}{d}\right)\frac{v^2}{2g}.$$

$$v=\frac{\sqrt{2gh}}{\sqrt{1+e+c\times\frac{l}{d}}}.$$

h—head of water in feet.
l—length of pipe in feet.
d—diameter of pipe in feet.
v—velocity in feet per second.
c—coefficient for friction in pipe.
e—coefficient of resistance for entrance into pipe.

$$c=\cdot01439+\frac{\cdot016921}{\sqrt{v}}.$$

The following table gives the different values of c for varying velocities:—

v	c	v	c	v	c
·1	·0679	·7	·0346	3	.0242
·2	·0522	·8	·0333	4	.0229
·3	·0453	·9	·0322	6	.0213
·4	·0411	1·0	·0313	8	.0204
·5	·0383	1·5	·0282	12	.0192
·6	·0362	2·0	·0263	20	.0182

c is at an average ·505, but may be reduced to ·08 by rounding off the inlet.

For $h=v$, and 1 : i—rate of inclination.

$$v=\frac{64\cdot38}{1505+\frac{c\,v\,i}{d}}$$

It will be seen from this formula that different coefficients are used for varying velocities. It should be fully borne in mind by those carrying out works of sewerage that gravity is the sole cause of motion. The motion of the particles of water in the sewer is wholly due to the inclination of the surface. When a fluid is brought to rest its surface will be horizontal, and when the surface is in that position the action of gravity ceases and the fluid ceases to flow. But so soon as the surface becomes inclined motion recommences, although the bottom of the channel may be horizontal, or even have an inclination opposed to that of the flow of the water. Water flowing through a sewer is subject to certain accelerating forces, so that, if it did not encounter any resistance, it would descend with an accelerating speed, just the same as any heavy body falling through air or running down an incline plane. But in a sewer, or channel, used for the conveyance of water, certain retarding forces are at work which are equal to and destroy the accelerating force at every moment. Resistance in the case of a sewer is that offered by the bed and sides of the channels. It is assumed by many authorities on hydraulics that the velocity is retarded, owing to the attraction of the particles of fluid in motion, by those particles of the fluid which adhere to the walls of the channel. If this is true the resistance of the flow of water depends, not so much upon the nature of the material composing the channel, as all materials more or less have an attraction for water, and in a channel a lamina of water is consequently spread over their surface. The experiments of Dubuat failed to show that there was any variation in the friction of water in channels of glass, lead, iron, or wood, so that for all practical purposes the nature of the materials of which a sewer is constructed need not be taken into consideration. That portion of the channel in a sewer or watercourse which is touched by the water is termed the wetted perimeter, and the greater the proportion of the wetted perimiter to the volume to be discharged the greater will be the resistance. Resistance is therefore in the inverse ratio to the section, and increases directly as the velocity. In all calculations of the discharge of water through sewers or channels, it is requisite to determine, with accuracy, the extent of the wetted perimeter, and also the sectional area of the water-way. By dividing the sectional area of the channel by the wetted perimeter, or the contour of the wetted channel, we get what is called "the mean hydraulic depth," or often, "the mean radius." In all circular sewers it is easy to determine the hydraulic mean depth, or mean radius, as the proportion between the wetted perimeter and the area, both when the sewer is running full or half full, is the same and invariably equals one-fourth the diameter of the sewer. The hydraulic mean depth of egg-shaped sewers varies with the volume of water flowing through them, but when such sewers are of the usual proportion, the hydraulic mean depth when running full is found by multiplying the transverse diameter by 0·2897; when running two-thirds full by 0·3157; and when running one-third full by 0·2066. The perimeter of an egg-shaped sewer when running full equals 3·9649 times the transverse diameter. When running two-thirds full it is equal to 2·3941 times the transverse diameter, and when running one-third full it is equal to 1·3747 times the transverse diameter of the sewer.—*Latham's Sanitary Engineering.*

RAILROAD CONSTRUCTION seems to be in a bad way the world over. The recent report of the British Board of Trade of the exports for the first half of the year show that 259,307 tons of railroad iron of all kinds were exported in 1875, against 427,297 tons in 1874. The exports last year were sufficient to lay 4,805 miles of track with 56-lb. iron; those of this year, only enough for 2,947 miles, or 1,858 miles less. Roughly speaking, the exports of this year were about sufficient for the maintenance of 40,000 miles of ordinary iron track during the half-year.

All this is evidence that the suspension of railroad construction has been general, and not confined to the United States alone. Of course England is not the only manufacturer of rails, but it is by far the greatest *exporter* of rails, and its exports are a pretty good clue to the activity in construction in countries which do not produce rails. For the last half-year no country has taken rails enough to make 500 miles of road, which would hardly leave any margin for new construction in a country with 3,000 miles of railroad to maintain carrying a considerable traffic.